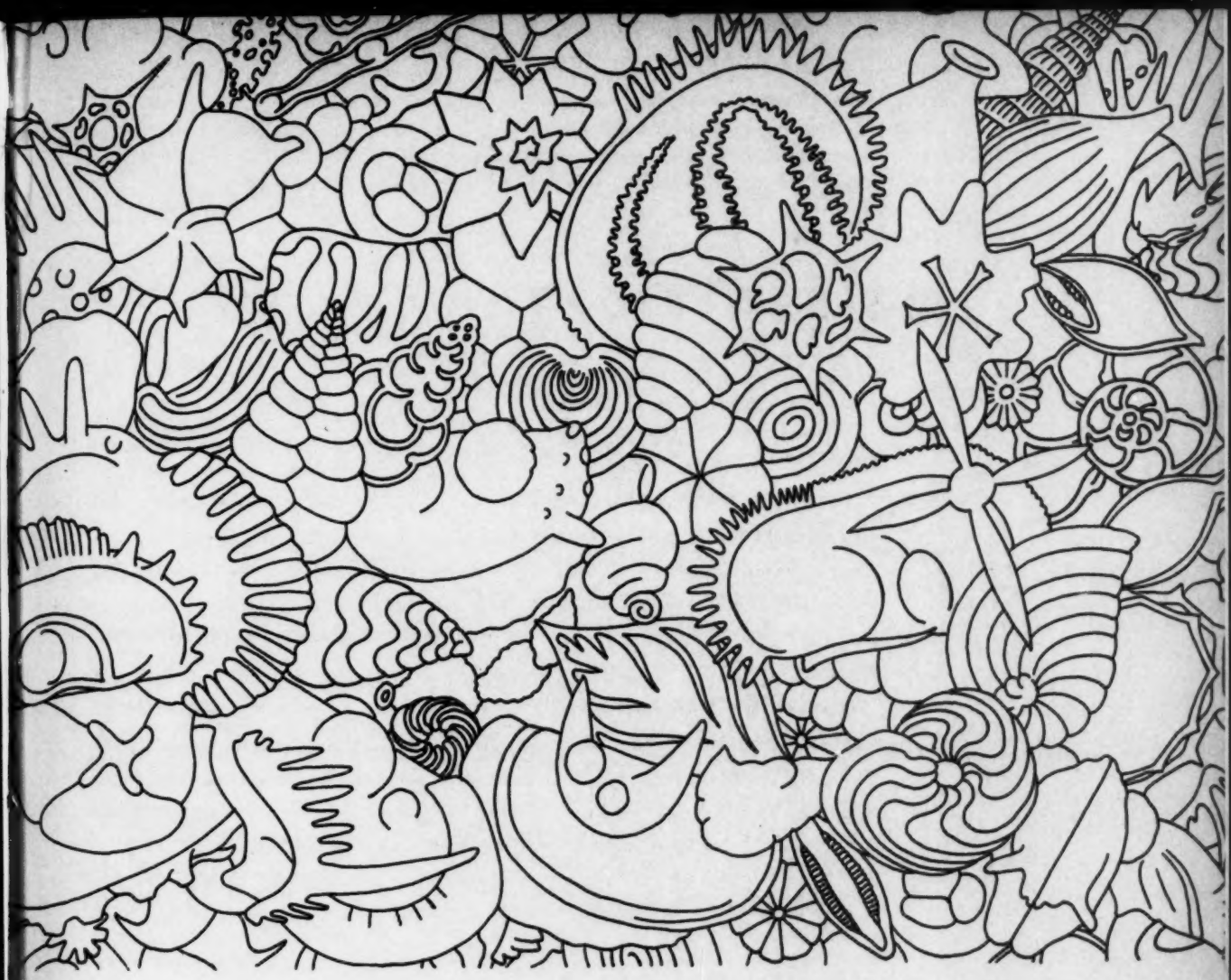

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ABSTRACT: *A more complex system of nomenclature is necessary to reflect adequately the complexity and high degree of specialization in the cytherid ostracods. Several new generic criteria are proposed for certain major groups of Cytheracea. The basic concepts involved are probably applicable to most cytherids. All of the structures considered lie on the ventral surface of the carapace.*

A new concept in ostracod taxonomy

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INTRODUCTION

Good taxonomy, as well as practical application in correlation and ecology, demands a refinement of classification consistent with the size and complexity of the taxon under consideration. Evolution, and especially stratigraphy, owe much of their present status to the liberation of paleontology from the too-inclusive usage of such generic names as *Fusulina* in the foraminifera, *Productus* and *Spirifer* in the Brachiopoda, and *Ammonites* in the Cephalopoda.

The systematic nomenclature of the cytherid Ostracoda is inconsistent with modern taxonomic practice in other taxa of similar size and complexity. The criteria commonly used for generic differentiation, significant though they may be, are of insufficient sensitivity to reflect accurately the degree of specialization in the cytherids. Strict application of these criteria results in the grouping of hundreds of highly specialized species under a few long-ranging "form" genera. If the cytherids are to attain their potential scientific and practical value, the first essential is a workable system of nomenclature based upon genetically sensitive characters that are compatible with a natural classification. No such system exists, due to lack of recognition of appropriate basic characters.

The existence of this problem is widely recognized among ostracod workers. In recent years many cytherid genera have been based upon various combinations of features of the surface ornamentation. Although these genera may well be valid, the basic taxonomic problem remains unsolved. There is little agreement regarding the particular surface features that will most effectively permit the evolution of a natural classification of the cytherids, and there is virtually no agreement regarding the relative importance of those characters that have been used. Many descriptions of such nominal genera seem merely to describe the ornamentation of the type species and to leave it to the discretion of the reader to decide which characteristics are of generic value. A remark by Stephenson (1946, p. 306) is appropriate in this context: "...each genus must possess one or more constant shell characters which shall in every case separate that genus from all others." To this might be added the self-evident qualification that to be of value these characters must be recognized as such.

The basic premise of this paper is as follows: *All of the species of a natural cytherid genus are similar with respect to the ventral structures and in the general aspect of the ventral surface.* The characters of the ventral surface, applied to taxonomy in conjunction with recognized criteria, make possible generic descriptions in complete accord with Stephenson's observation, and satisfy the requirements of a highly refined nomenclature.

Most living cytherids crawl slowly along the bottom, and rarely if ever swim freely through the water. In many Recent and fossil species the carapace, especially the ventral portion, seems admirably adapted to such a mode of life. If the manner and means of cytherid locomotion was essentially the same in the past as at present, the ventral surface has been the area of the carapace in most intimate contact with the environment, and therefore suggests itself as one in which characters of taxonomic value might be found. The truth of this suggestion can be demonstrated in much greater degree than

might have been anticipated. Although the interpretation of some of the ventral structures in terms of survival value to the organism is not entirely clear at present, one trend which can be seen in many different types of Cytheracea is the tendency, through modifications of the several structures, to develop a broad, flat ventral area, presumably to lower the center of gravity and to give the animal greater stability. The ventral surface of the cytherid carapace may include as many as four distinct characters of generic importance. These are (1) the contact relationship of the valves; (2) marginal crests; (3) the fundium; and (4) lateroventral crests.

The following discussion, except for the part dealing with contact relationships, applies primarily to the hemicytherids, brachycytherids, and trachyleberids, but with appropriate modification the principles discussed may be applicable to most Cytheracea. The ventral surface can be most easily studied in a carapace in which the valves are tightly closed; this condition is assumed in the discussions of the various structures. The terminology is that of Kesling (1951), except where new terms have been found to be necessary. A glossary is appended.

CONTACT RELATIONSHIP

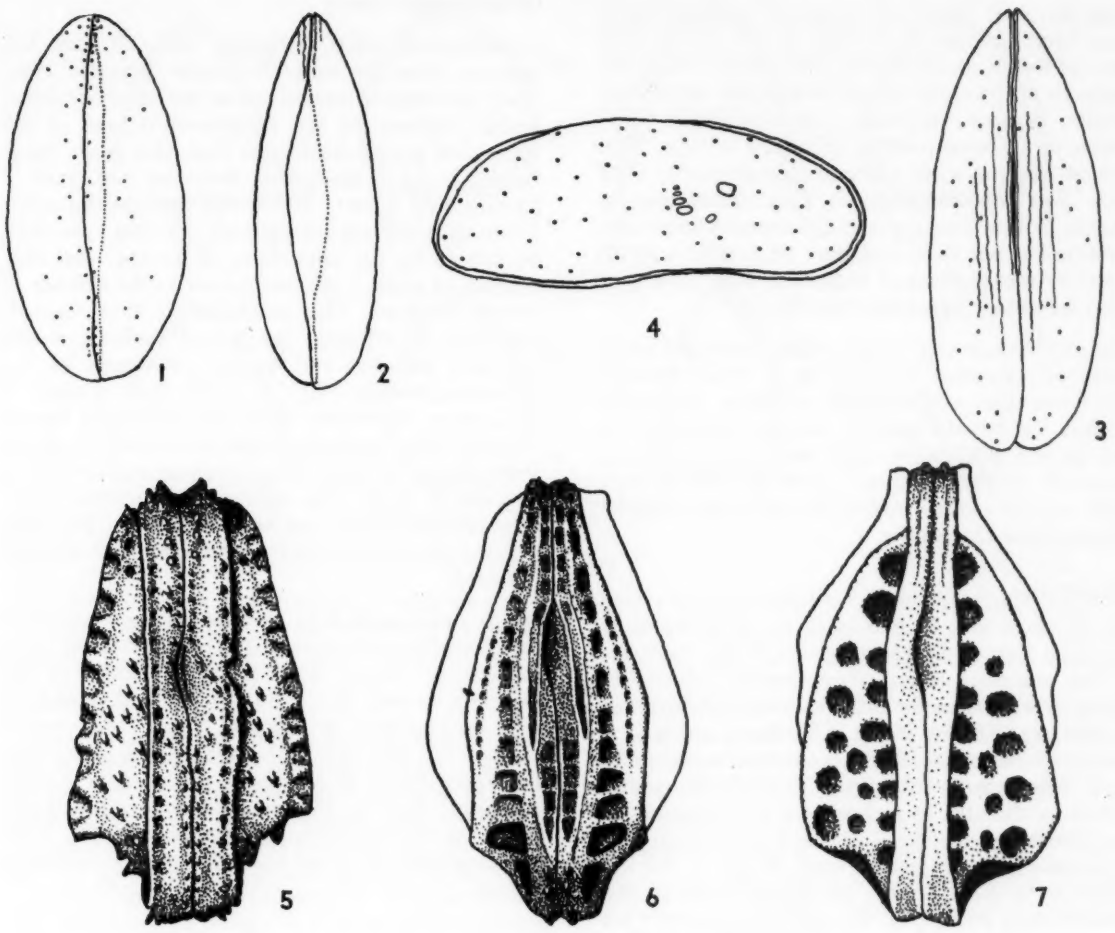
The contact relationship of the valves ("overlap") has long been used to differentiate certain genera of Cypridacea. Apparently, however, the importance of this characteristic to podocopid systematics in general has not been fully appreciated. Most Podocopa have corresponding sections of the contact margins of the two valves modified in such a manner that they remain in contact when the valves are slightly agape. This ventral structure, here named the *ventriculus*, is probably analogous in function to the rostral sinus of the Myodocopa, permitting protrusion of appendages while the free edges of the valves remain partially in contact. *Ventricular overlap* is always visible in ventral view (text-figs. 1–2), but in some genera the position of the ventriculus is shown externally only by a *ventricular anomaly*. This may be any of several anomalous conditions, such as a *ventricular depression* or flattened area lying athwart the contact line, or, especially in cases where the valves meet ventrally at an acute angle, it may be a *ventricular concavity* of the ventral margin (text-fig. 3). The ventricular anomaly is always located on the ventral contact line, usually slightly anterior to midlength.

A discussion of all the existing types of contact relationship is beyond the scope of the present work, but a few examples will suffice to illustrate the more common types. Only the exterior manifestations of often complex relationships will be considered here. It must be emphasized that similarity of contact relationship does not in itself imply close phyletic relationship. Major differences in contact relationships seem to be ample basis for generic differentiation, but similar conditions may exist in genera which are obviously not closely related.

The simplest and perhaps the most primitive type of contact in the Cytheracea is *exoventricular contact*, in which conspicuous ventricular overlap extends along much of the ventral contact line. This is present in *Cytheretta* (text-fig. 1), *Xestoleberis*, *Basslerites*, and *Neocytherideis* (text-fig. 2), and serves to differentiate the latter from the otherwise similar *Hemicytherideis*. A slightly more complex type of exoventricular contact is present in *Protocythere triplicata* (Roemer), in which the smaller right valve has a well defined "shelf" to accommodate the contact margin of the overlapping left valve. *Endoventricular contact* is exemplified in *Hemicytherideis elongata* (Brady), in which the contact margin of the larger left valve is modified to accommodate the thin edge of the right valve. In ventral view the contact line of this species appears as an essentially straight line, which bisects the ventral surface of the carapace (text-fig. 3), the ventricular anomaly being represented by a slight flattening of the surface athwart the contact line, which in lateral view is shown by a ventricular concavity in the ventral margin (text-fig. 4). *Mesoventricular contact* combines essential features of the two types discussed above and is the most complex type of contact. The contact margins are modified for mutual accommodation, and the ventriculus is represented externally by an overlapping *ventricular lip* (text-figs. 5–7), which often lies within a ventricular depression. This type of contact is present in many genera, including most of the forms formerly assigned to *Cythereis*.

MARGINAL CRESTS

The marginal crests are twin crests or ridges, one on either valve, which usually closely parallel the contact line except that they may diverge around the ventricular area in a *ventricular flexure* (text-fig. 7). They are present in many cytherid taxa, and it seems not unlikely that, when cytherid families and subfamilies are more realistically delimited and more objectively defined, they may prove to be of taxonomic value at the family-group level. Obviously they serve to strengthen the valve margins, but



TEXT-FIGURES 1–7

1, *Cytheretta subradiosa* (Roemer), ventral view; 2, *Neocytherideis fasciata* (Brady and Norman), ventral view; 3–4, *Hemicytherideis elongata* (Brady): 3, ventral view; 4, right lateral view; 5, *Carinocythereis carinata* (Roemer), ventral view; 6, *Aurila? jollaensis* (LeRoy), ventral view; 7, *Hermanites* sp., ventral view. Figs. 1–5, Recent, Porto Corsini, Italy; 6, Pleistocene, California; 7, Paleocene, Saudi Arabia. All figures × 75.

this function seems scarely important enough to account for their great taxonomic significance. The restriction of this paper to consideration of the ventral surface is by no means arbitrary with respect to these structures. Although they often extend along the anterior and posterior margins, their form is often somewhat different in these places and is apparently of little value above the species level. As will be seen later, important evolutionary changes in the marginal crests often originate on the ventral surface in the vicinity of the ventriculus.

The general form of cytherid marginal crests ranges from high sublamellate ridges to low flattened structures with greater width than thickness; the majority of forms fall near a midpoint between these extremes. The crests may be smoothly rounded to acutely angled, and occasionally are represented by a row of spines which, in the case of *Carinocythereis carinata* (Roemer) (text-fig. 5), coalesce into a thin lamella. Frequently they are inclined outward distally along part or all of their ventral extent, this condition often being most pronounced in or occasionally restricted to the ventricular flexures.

Thus far, only the simple types of marginal crests have been considered. At least by late Cretaceous time, however, an innovation occurred in which the segments of the crests that lie within the ventricular flexures became compound, either by simple bifurcation or by superposition of a row of pits. This process in some cases continued progressively until each crest was longitudinally split throughout its length. In late Tertiary and Quaternary forms this condition is not rare, and may be further complicated by the addition of transverse bars, spines, or other secondary structures (text-fig. 6).

The major types of variation of the marginal crests have been discussed, but these by no means exhaust the taxonomic potentialities of these structures. Within the limited generic concept advocated in this paper, qualitative and relative quantitative variation of the marginal crests is usually very slight on the ventral surface except at the anterior and posterior extremities.

THE FUNDIUM

The fundium may be defined as the flattened areas on either side of the ventral contact line, exclusive of the marginal crests when present, which are sharply set off from the lateral surfaces. A flattened venter (text-fig. 8e) is not a fundium unless it is sharply differentiated from the lateral surfaces. In view of the fact that the fundium forms the ventral surface of the alae in such genera as *Pterygocythereis* and *Hermanites* (text-fig. 7), it has already been used in taxonomy at the generic level. However, the importance of the fundium, as distinct from related lateroventral extensions, has apparently never been recognized. The less conspicuous fundia of many other genera are fully as important taxonomically as is the hyperdeveloped fundium of *Pterygocythereis*. The fundium seems to have developed independently in many cytherid groups, but the writer knows of no case in which the loss of a fundium, once developed, can be demonstrated. The fundium is probably of little value at taxonomic levels above the generic, but any appreciable difference in the overall shape or relative size of the fundium seems sufficient to justify generic differentiation.

In the cytherid groups specifically considered here, the ornamentation of the fundium seems to be similar in all the species of a genus, and is usually not conspicuously different from that of the lateral surfaces. In certain other groups not considered in this paper, the ornamentation of the fundium is often quite different from the lateral ornamentation. Investigation of its taxonomic significance should prove fruitful.

LATEROVENTRAL CRESTS

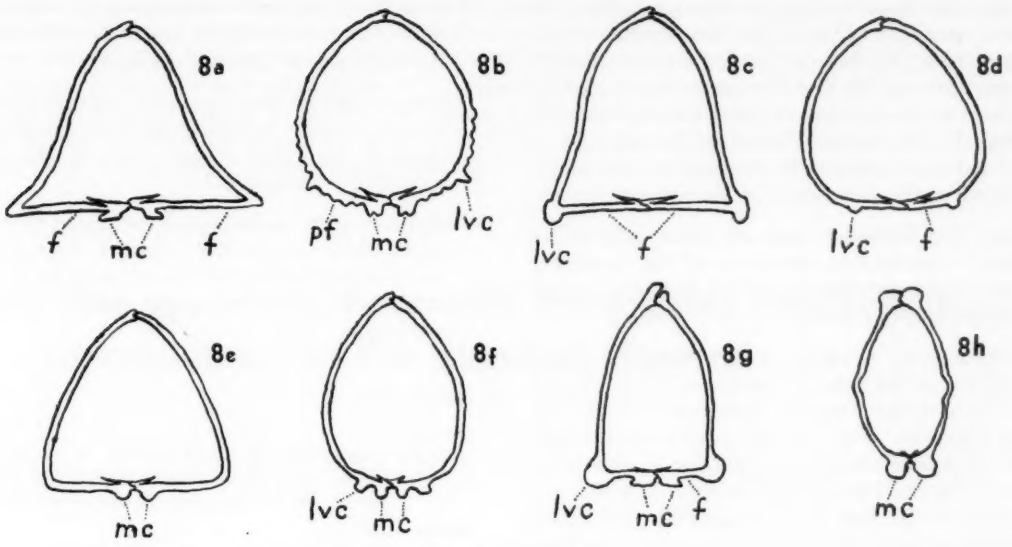
Lateroventral crests, although not rare, are less common than the other structures discussed here. They are ridges of shell material, one on either valve, which originate in the anteroventral area of the valve and extend backward from this point (text-fig. 6). It seems likely that there are two types of lateroventral crests, which are not homologous. Study of many genera suggests that one type may be formed by the alignment, thickening, and coalescence of surface ornamentation in the absence of a true fundium. The *pseudofundium* thus formed, although set off from the lateral surfaces, is not flattened but has the normal curvature of the carapace (text-fig. 8b). The other type of crest, if a fundium is present, forms the thickened lateral margins of the fundium; in the absence of a fundium they are nearly parallel to the marginal crests and lie close to them. The latter type, therefore, may originate parallel to and near the contact line, and generate the fundium as their posterior ends migrate outward.

Much work remains to be done on the origin and function of these structures. The crests probably serve in part to remedy a structural weakness of the carapace caused by ventral broadening, and thus may be analogous in function to the concrescence of the valve walls along the distal edges of the alae in *Pterygocythereis*. Regardless of the function of these structures, they are of great taxonomic value. Their degree of development, position, and general form are characters of great value for generic differentiation.

MISCELLANEOUS OBSERVATIONS

No attempt has been made to apply ventral characteristics to the problem of species differentiation in the cytherids; in the course of work on the present paper, however, it has been noted that small but consistent differences in the ventral structures or in the ventral ornamentation are often the most apparent differences between closely related species. Conversely, ecologic variants of less than subspecific importance, as well as sexual dimorphs, can often be assigned with confidence to the same species on the basis of identical ventral ornamentation.

The ontogenetic development of the ventral structures has not been studied. Such a study might be of great value as an aid to the investigation of cytherid evolution and could also yield valuable information regarding the origin and evolutionary development of the various ventral structures.



TEXT-FIGURE 8

Hypothetical sections of various types of ostracods showing structures discussed in the text. Symbols: *lvc* = lateroventral crest; *f* = fundium; *pf* = pseudofundium; *mc* = marginal crest.

DISCUSSION

The writer anticipates little dissension regarding the essential validity of the proposed criteria. The ultimate argument that may be expounded in their favor is that they "work," that is, they make objective generic diagnoses possible; the genera so defined are often stratigraphically and ecologically restricted; and two or more such nominal genera can sometimes be related in a series which appears to be evolutionary. These same conditions might be used to demonstrate the meaning of the expression "valid taxonomic criteria." This paper is based upon a study of dozens of faunules of Jurassic to Recent age from areas distributed throughout much of the world. A cursory examination of much less material, however, should adequately demonstrate the validity of the basic criteria. The severely restricted generic concept advocated may be less readily accepted. Full application of this concept will result in a large number of new generic names and, eventually, many more family-group taxa. In so large and diversified a group as the Cytheracea, such complexity seems eminently desirable.

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The author is indebted to officials of The Arabian American Oil Company for permission to publish this paper; to Professor Giuliano Ruggieri and to Dr. Erich Triebel for valuable specimens of ostracod type species; and to Dr. R. A. Bramkamp, Dr. J. J. Donohue, and Mr. R. L. Painter for their constructive criticism of parts of the manuscript.

GLOSSARY

Contact line: The line formed by the contact of the valves in a tightly closed carapace, exclusive of the hinge line.

Contact margin: "The area of a valve, exclusive of the hinge, which is in contact with the opposite valve when the two are closed" (Kesling, 1951, p. 111). Kesling further states that "the distal limit of the contact margin is the free edge." See remarks under "free edge."

Endoventricular contact: The type of valve contact in which there is little or no external overlap. Ventricular structures are not visible externally, although their position is indicated by a ventricular anomaly. In ventral view the visible areas of the two valves are similar in size and shape (text-fig. 3).

Exoventricular contact: The type of valve contact in which one valve conspicuously overlaps the other ventrally. In ventral view the visible areas of the two valves differ in size and shape (text-figs. 1–2).

Free edge: The distal limit of the exterior surface of a valve, exclusive of the hinge line. Kesling's definition (1951, p. 111) expresses the same concept as the "contact line" of this paper, but conforms to previous usage only in cases where overlap is absent. In the absence of overlap, the free edge of each valve coincides with the contact line and is the same as the distal limit of the contact margin.

Fundium: The flattened areas on either side of the ventral contact line exclusive of the marginal crests, which are sharply set off from the lateral surfaces (text-figs. 7–8).

Lateroventral crest: A ridge of shell material which originates in the anterior portion of the valve and extends backward, usually diverging from the free edge (text-figs. 5–6). If both lateroventral crests and a fundium are present (text-fig. 6), the crests form the lateral limits of the fundium. If a pseudofundium is present, it is invariably delineated laterally by lateroventral crests (text-fig. 5). (Also see text-fig. 8.)

Marginal crest: A ridge of shell material which lies close to and nearly parallels the free edge (text-figs. 5, 7–8).

Mesoventricular contact: Similar to endoventricular contact except that a ventricular lip is present (text-figs. 5, 7).

Pseudofundium: A fundium-like structure set off from the lateral surfaces by lateroventral crests. Differs from a fundium in retaining the normal curvature of the carapace instead of being flattened (text-figs. 5, 8).

Ventricular anomaly: Any of several anomalous conditions associated with the ventriculus when the contact is endoventricular.

Ventricular concavity: A concave portion of the ventral margin, usually somewhat anterior to midlength, which corresponds to the position of the ventriculus (text-fig. 4).

Ventricular depression: A flattened or concave area athwart the contact line at the position of the ventriculus. May be present in both mesoventricular and endoventricular contact (text-figs. 5–7).

Ventricular flexure: An arch of the marginal crests around a ventricular depression or a ventricular lip (text-fig. 7).

Ventricular lip: A small overlapping lip which forms part of the ventriculus in cytherids with mesoventricular contact (text-figs. 5–7).

Ventricular overlap: The condition, typical of exoventricular contact, in which one valve conspicuously overlaps the other along much of the ventral contact line (text-figs. 1–2).

Ventriculus: Any modification of the ventral free edges which permits the valves to remain in contact ventrally while they are slightly agape at the extremities. Usually located slightly anterior to midlength.

BIBLIOGRAPHY

HILL, B. L.
1954 – *Reclassification of winged Cythereis and winged Brachycythere.* Jour. Pal., vol. 28, no. 6, pp. 804–826, pls. 97–100.

HOWE, H. V.
1951 – *New Tertiary ostracode fauna from Levy County, Florida.* Florida, Geol. Survey, Geol. Bull., no. 34, pp. 1–43, pls. 1–5.

KESLING, R. V.
1951 – *Terminology of ostracod carapaces.* Michigan, Univ., Mus. Pal., Contr., vol. 9, no. 4, pp. 93–171, pls. 1–18, text-figs. 1–7, 5 charts.

PURI, H. S.
1952 – *Ostracode genus Cytherideis and its allies.* Jour. Pal., vol. 26, no. 6, pp. 902–914, pls. 130–131, text-figs. 1–14.

1953 – *Contribution to the study of the Miocene of the Florida Panhandle; Part III — Ostracoda.* Florida, Geol. Survey, Geol. Bull., no. 36, pp. 215–345, pls. 1–17, text-figs. 1–14.

RUGGIERI, G.
1952 – *Nota preliminare sugli ostracodi di alcune spiaggie adriatiche.* Bologna, Univ., Ist. Zool., Lab. Biol. Mar. Fano, Note, vol. 1, no. 8, pp. 57–64, text-figs. 1–4.

STEPHENSON, M. B.
1946 – *Weches Eocene Ostracoda from Smithville, Texas.* Jour. Pal., vol. 20, no. 4, pp. 297–344, pls. 42–45, text-fig. 1.

TRIEBEL, E.
1938 – *Protocythere und Exophthalmocythere, zwei neue Ostracoden-Gattungen aus der deutschen Kreide.* Senckenbergiana, vol. 20, no. 1/2, pp. 179–200, pls. 1–3.

1940 – *Die Ostracoden der deutschen Kreide; 3 — Cytherideinae und Cytherinae aus der Unteren Kreide.* Ibid., vol. 22, no. 3/4, pp. 160–227, pls. 1–10.

1941 – *Zur Morphologie und Ökologie der fossilen Ostracoden, mit Beschreibung einiger neuer Gattungen und Arten.* Ibid., vol. 23, no. 4/6, pp. 294–400, pls. 1–15.

1950 – *Homöomorphe Ostracoden-Gattungen.* Ibid., vol. 31, no. 5/6, pp. 313–330, pls. 1–4.

ABSTRACT: *The structural and stratigraphic geology of the island of Majorca is outlined in order to show the stratigraphic positions in the Lower and Middle Miocene occupied by the foraminiferal species cited in the text. Discordance exists between the Lower Miocene (Burdigalian) and the Middle Miocene (Helvetian-Tortonian). In the Burdigalian,* Miogypsina mediterranea *is associated with foraminifera of "Caribbean" type which are frequent in the "Upper Oligocene" and Lower Miocene of Central America, as well as in the Balearic Islands. In the Helvetian-Tortonian, other associations, which are very different from these but which are frequent in the Middle and Upper Miocene and Pliocene of the Mediterranean zone, are found.* Miogypsina *has not previously been observed in the Helvetian-Tortonian of Majorca.*

The age of the beds with Miogypsina mediterranea Bronnimann on the island of Majorca

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INTRODUCTION

Students of the microfaunas, stratigraphy and sedimentation of the Balearic Islands will not readily agree with Drooger (1956, p. 192, no. 19) that the beds on the island of Majorca containing *Miogypsina mediterranea* Bronnimann are of Helvetian age. *Miogypsina mediterranea* seems to be a good Lower Miocene fossil there, and is lacking, on the other hand, in the Vindobonian (Helvetian-Tortonian).

It is frequently accompanied in Burdigalian deposits by *Globigerina dissimilis* Cushman and Bermudez, but the latter is always scarce. The predominant globigerinid deposits in the Burdigalian seas of the Balearic zone were composed of *Globigerina conglomerata* Schwager and *Globigerinoides triloba* (Reuss); the latter still existed in large numbers in the Helvetian, but *Globigerina conglomerata* disappeared in the Lower Miocene (= Burdigalian).

Miogypsina mediterranea is also associated in the Burdigalian beds of Majorca with an assemblage of benthonic species that are found in the "Upper Oligocene" – Lower Miocene of Central America, and are also peculiar to the latter stage in the Mediterranean region. For example, in the Burdigalian deposit of Malpas (Alcudia, Majorca) mentioned by Drooger (1956, p. 192), *Globigerina dissimilis* and *Miogypsina mediterranea* occur together with the following forms (in this list and in all subsequent lists, A = abundant; F = frequent; R = rare; and VR = very rare):

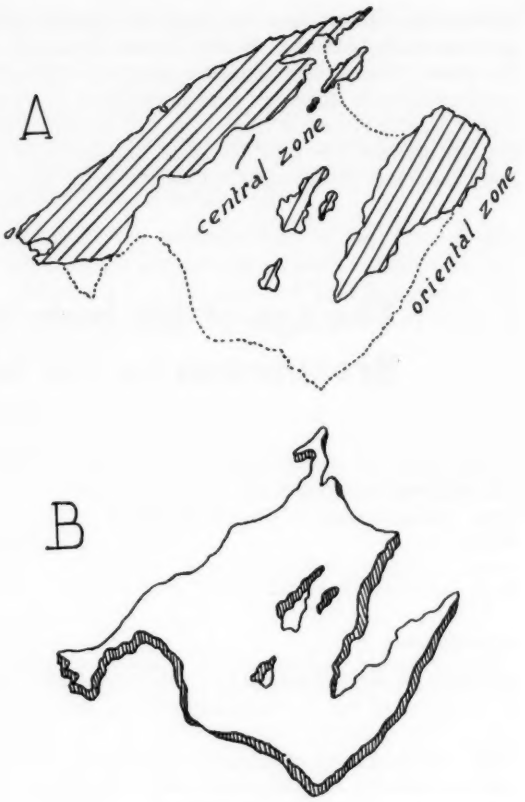
Amphistegina lessonii d'Orbigny	A
Anomalinoides pompilioides (Galloway and Heminway)	F
Astacolus nuttalli jordai Colom	A
Chilostomella cylindroides Reuss	R
Cibicides barnetti Bermudez	F
Cibicides mexicanus Nuttall	R
Cibicides subtenuissimus (Nuttall)	R
Chrysalogonium asperum Cushman and Stainforth	VR
Chrysalogonium elongatum Cushman and Jarvis	A
Chrysalogonium longicostatum Cushman and Jarvis	F
Chrysalogonium tenuicostatum Cushman and Bermudez	VR
Cylindroclavulina bradyi (Cushman)	VR
Ellipsoglandulina multicostata (Galloway and Morrey)	F
Elphidium crispum (Linné)	F
Frondicularia alazanensis Cushman	F
Gypsina globulus (Reuss)	R
Karreriella hantkeniana Cushman	VR
Karreriella subcylindrica (Nuttall)	A
Lagenonodosaria spinicosta adelinensis Cushman and Bermudez	R
Lingulina ponceana (Galloway and Heminway)	VR
Nodosarella subnodosa (Guppy)	F
Planulina renzi Cushman and Stainforth	A
Pseudoglandulina gallowayi Cushman	R
Rectuvigerina seriata Cushman	F
Robulus alatolimbatus (Gümbel)	R
Robulus antipodum (Stache)	R

Stilostomella paucistriata (Galloway and Morrey) F
Stilostomella recta (Palmer and Bermudez)..... F
Textularia rugosa (Reuss) ..... R

Miogypsina mediterranea was described by Bronnimann (1940) from the Burdigalian of North Africa (Untermiocaen, Grande Vallée de Basra, Maroc). Its presence in the Burdigalian of Majorca and Iviza agrees perfectly with its stratigraphic occurrence in North Africa. This is not surprising in the case of deposits so near each other. However, to consider the beds with *Miogypsina mediterranea* of Majorca as Helvetian, as Drooger suggests, completely upsets all our present ideas concerning the succession of Miocene terrains in the Balearics, a stratigraphic succession established by Hermite (1879), Nolan (1895), Hoernes (1905), Fallot (1922), Darder (1929), and other geologists on the basis of other fossils such as pectinids and echinoids. I do not by any manner of means pretend to consider Balearic stratigraphy free from all problems. Nevertheless, the interesting point, in the case of Majorca and Iviza, is that if any change in the position of the beds with *Miogypsina mediterranea*, that is to say the Burdigalian (Lower Miocene) beds, were to be made, it should be to place them somewhat lower, and to consider them Aquitanian, rather than to raise them into the Helvetian.

The Burdigalian foraminiferal assemblages of the North Betic Strait and of the Balearic Islands (Colom and Gamundi, 1951; Colom, 1952) contain many Caribbean species originally described from "Upper Oligocene" or Lower Miocene Central American levels. The proportion of these species is considerable. We find all of them in Spain, Italy, and North Africa in the Lower Miocene (= Burdigalian of Spanish and French authors, Langhian of the Italians). Nearly all of them became extinct in these countries at the end of the Lower Miocene or migrated toward southern seas in search of more temperate climates. Very few of them passed into the Vindobonian. *Miogypsina mediterranea* is always associated with this type of microfauna, forming a micropaleontological assemblage easy to distinguish from that of the Vindobonian (Helvetian–Tortonian) beds. The latter assemblage is composed of species of a more recent type, which arrived with the Vindobonian transgression. The greater part of them lived on into the Pliocene and Recent. *Miogypsina*, however, is no longer observed among them.

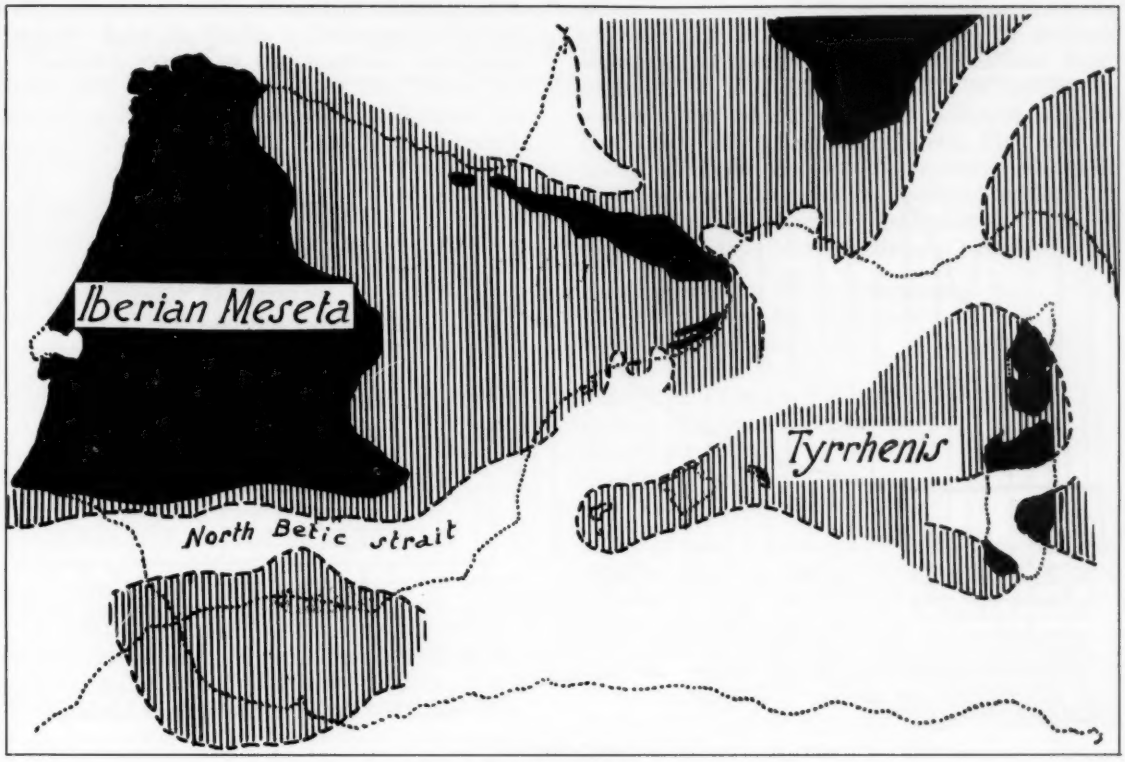
A brief account of the geology of the Miocene terrains of the Balearics will be given here, in an attempt to contribute toward a better understanding of the stratigraphic correlations between the foraminiferal populations of the Mediterranean and their equivalents in Central America. It seems particularly appropriate to do so at a time when the relationships between the associations of the "Upper Oligocene" and Lower Miocene of the Caribbean and those of the Lower Miocene (= Burdigalian or Langhian) of the Mediterranean region are beginning to be recognized.



TEXT-FIGURE 1
STRUCTURAL GEOLOGICAL ARRANGEMENT OF THE ISLAND OF MAJORCA

MIOCENE STRATIGRAPHY OF THE BALEARICS

In the Balearic Islands the Miocene is represented by the deposits of two marine transgressions. The first, the Burdigalian, extended widely throughout the entire Mediterranean area. Its deposits were included in the orogenic post-Burdigalian Alpine phase (Stille's Stairic foldings), which gave Iviza and Majorca their present mountain relief. The transgressive beds of the Helvetian were deposited upon these young uplifts, and form a large, compact, and united tabular mass overlying the Stairic folds (text-fig. 1).



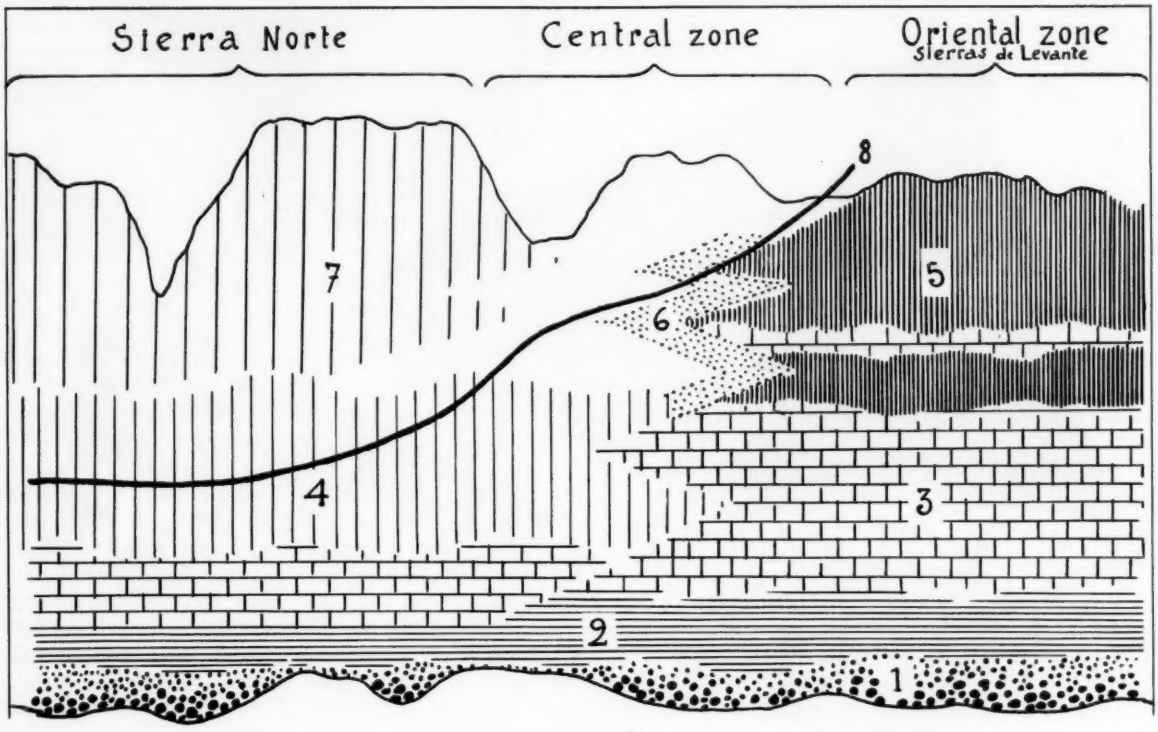
TEXT-FIGURE 2

PALEOGEOGRAPHIC RECONSTRUCTION OF THE WESTERN MEDITERRANEAN AREA DURING THE AQUITANIAN

These facts were first demonstrated by Professor Darder in 1924, and they have been accepted by all geologists working on Balearic stratigraphy since that time. Consequently, the deposit of Malpas (Alcudia), as well as the many others that contain *Miogypsina mediterranea* and *Globigerina dissimilis*, is considered to be Burdigalian, that is, belonging to the first transgression. The geologic and sedimentary history of the two transgressions is as follows:

At the close of the Upper Oligocene, the area corresponding to the present Balearic Islands was subjected first to a series of Savic foldings, and finally to a general emergence that united its terrain with those of Tyrrhenis during the course of the Aquitanian (Upper Oligocene) (text-fig. 2). As a result, this marine stage is lacking in the three islands, and there is also evidence that the lower Burdigalian is represented by lacustrine and continental formations with remains of plants (Arènes, 1951; Colom, 1951). But the marine transgression of the Burdigalian soon covered these uplifts with thick basal conglomerates (text-fig. 3, no. 1). With the stabilization of the transgression there began an intense detrital sedimentation that gave rise first to arenaceous and later to calcareous beds. This detrital sedimentation developed more widely in the eastern region (text-fig. 3, no. 3) because of the influence exercised upon it by the emerged Tyrrhenian mass (Minorca) (text-fig. 4), and the deposits correspond for that reason to a distinct littoral zone. Later, thick deposits of marly sandstones, heavily charged with terrigenous elements, were formed. Their most important development corresponds to the central region and to the Sierra Norte; in the eastern zone, limestones and finally coarse arenaceous formations occur (text-fig. 3, nos. 4 and 5).

At the end of this first uniform detrital phase, three distinct zones of sedimentation developed in the area of Majorca and Iviza (text-fig. 4): A littoral zone, characteristic of the eastern region (Sierras de Levante), receiving continuous detrital material, and poor in organic remains; a central zone of marly sandstone and finally of fine-grained marls, in which a glauconitic zone rich in diatoms, dependent on



TEXT-FIGURE 3

GEOLOGIC SECTION OF THE BURDIGALIAN SEDIMENTS OF THE ISLAND OF MAJORCA

the continental talus of Tyrrhenis, appeared during the later phase of the transgression; and a third zone, the most pelagic in character, corresponding to the territory of the Sierra Norte (text-fig. 3, no. 7) and containing abundant marly deposits. The Burdigalian marls are gray or bluish in color and are known to Spanish geologists as "moronitas" (Colom and Gamundi, 1951; Colom, 1952). They are filled with planktonic organisms, both calcareous (*Globigerina*, discoasters, Coccolithophoridea) and siliceous (Radiolaria, silicoflagellates, etc.). All grades of transition can be found, of course, between these three sedimentary zones at their points of contact.

The higher marly series of the central region and of the Sierra Norte (text-fig. 3, no. 7) were evidently situated at quite a distance from the coast at the close of the Burdigalian, as their very fine-grained beds, with only rare diatoms and grains of glauconite, indicate. They were largely destroyed by erosion during the post-Burdigalian phase of emergence and folding, and only fragmentary remains of them are left.

The marly series of the central zone and Sierra Norte (text-fig. 3, nos. 4, 6, 7), with their bluish marls filled with pelagic micro-organisms, are analogous to the marly series ("moronitas") with diatoms, Radiolaria, etc., of the North Betic Strait (Colom and Gamundi, 1951; Colom, 1952), which in their more littoral regions, contain Chattian or Aquitanian *Lepidocyclina* (text-fig. 2). Their associations of benthonic foraminifera are also similar to those of the Majorcan Burdigalian. The beds of this age from Majorca therefore show very close correlation with the Aquitanian beds of the Andalusian region. However, so far, no remains of *Lepidocyclina*, but only large populations of *Miogypsina mediterranea* Bronnimann and its variety *excentrica* Bronnimann, have been found in the three Burdigalian zones of Majorca.

The macrofauna of the different biotopes of the Burdigalian transgression is reduced to a small assemblage of lamellibranchs and echinoids. In the lithotopes of fine-grained sandstone (text-fig. 3, no. 2), echinoids of the genera *Scutella* and *Clypeaster* are found, and in the lithofacies of arenaceous marl

or clay (text-fig. 3, no. 4), *Pecten* and related genera. The most abundant species is *Chlamys praescabriusculus* Fontannes, with its two varieties, *catalaunicus* Almera and Bofill and *talarensis* Kilian, which are widely distributed in the typical Burdigalian formations of Catalonia and the Rhone Basin (France). They are accompanied by:

Amussium subpleuronectes (d'Orbigny)
Chlamys haueri Michelotti
Chlamys multistriata Poli
Chlamys northamptoni Michelotti
Chlamys opercularis Linné
Chlamys radians combaluzieri Morgan
Chlamys rotundata Lamarck
Chlamys scabrellus tarraconensis Almera and Bofill
Chlamys solarium Lamarck
Chlamys sub-holgeri Fontannes
Chlamys tournali De Serres
Chlamys varia interstriata Schaffer
Flabellipecten costisulcatus Almera and Bofill
Flabellipecten pasinii Meneghini
Pecten convexior Almera and Bofill
Pecten kochi Locchi

They are not all confined to the Burdigalian. In the Mediterranean area, some appear as early as the Aquitanian, whereas others persist into the Helvetian, but on the whole they indicate Lower Miocene levels. *Amussium subpleuronectes* is the species that appears in the stratigraphically oldest beds, and it is highly characteristic of the Aquitanian. In the lower beds of marly sandstone (text-fig. 3, no. 4), *Ostraea gingensis* Schlotheim is found; its appearance coincides with the Lower Miocene in the Mediterranean region, although its value as an index fossil is much debated. The presence of *Clypeaster*, such as *Clypeaster intermedius* Desmoulins, *Clypeaster scillae* Desmoulins, *Clypeaster grandiflorus* Bronn, *Clypeaster latirostris* Agassiz, *Clypeaster ludovici-salvatoris* Lambert, and *Clypeaster portentosus* Desmoulins, is yet another argument for considering these beds Burdigalian instead of Oligocene.

On the other hand, although the Helvetian–Tortonian sediments also contain basal conglomerates in their first transgressive phase, the latter are not as thick as those of the preceding transgression. A very characteristic foraminifer, *Neoalveolina melo* (Fichtel and Moll), appears in the lowermost fine-grained arenaceous beds and also extends into the higher beds of white molasse (Colom, 1946*c*). This species occurs in similar beds in the Vienna Basin, disappearing at the end of the Tortonian. Its presence indicates the Helvetian age of these transgressive formations from their lowermost strata upward. The remaining deposits of the Helvetian–Tortonian are characterized by a thick mass of white molassic limestone interbedded with hard yellowish limestones filled with Melobesias and, in certain localities, interbedded with thin yellowish argillaceous beds containing foraminifera. They are all neritic sediments, and as a whole reach a thickness of 100 meters. Their shallow biotopes contain large oysters (*Ostraea crassissima*), echinoids of the genus *Clypeaster*, and the following group of lamellibranchs:

Amussium cristatum badense Fontannes
Chlamys bollonensis Mayer-Eymar
Chlamys gentoni Fontannes
Chlamys malvinae Dubois
Chlamys melii Ugolini
Chlamys multistriata simplicula Sacco
Chlamys pes-felis (Linné)
Chlamys radians Nyst
Chlamys submalvinae Blanckenhorn

Some of these species extend to Pliocene levels in other localities. Numerous remains (teeth) of fishes characteristic of the Vindobonian are found together with the lamellibranchs.

The vertical distribution in the Mediterranean area of the lamellibranchs and echinoids found to date in the Burdigalian and Helvetian–Tortonian deposits of Majorca is given in Table 1.

Because of the ecologic differences between them, the two transgressions have different micro-organisms. In the first we find lithotopes of a shallow-water, highly detrital nature at the beginning of the transgressive phase, but the marly deposits become increasingly fine-grained and more filled with pelagic organisms with increased depth of deposition; a depth of some 500–600 meters may have been reached. The Helvetian transgression, on the other hand, left littoral sediments near a coast with numerous islands and islets formed by the young uplifts of the Stairic orogenic phase, which at that time had undergone little erosion.

Now that these fundamental differences in sedimentation characterizing the lithology of the two ages in question on the island of Majorca have been explained, the reader will be able to verify the stratigraphic positions of the different associations of foraminifera obtained from the various beds, by the use of the paleoecologic-stratigraphic chart given in text-figure 3. I hope, with these data, to facilitate their comparison and correlation with the associations occurring in similar beds on the other side of the Atlantic, as well as in the various areas of the Mediterranean region.

TABLE 1

	Aquitanian	Burdigalian	Helvetian	Tortonian	Pliocene	Recent
LAMELLIBRANCHS						
Amussium subpleuronectes (d'Orbigny)	●					
Chlamys rotundata Lamarck	●	●				
Pecten kochi Locchi	●	●				
Chlamys northamptoni Michelotti	●	●	●			
Flabellipecten pasinii Meneghini	●	●	●			
Pecten fuchsi Fontannes	●	●	●	●		
Chlamys opercularis Linné	●	●	●	●	●	●
Chlamys multistriata Poli	●	●	●	●	●	●
Chlamys praescabriusculus Fontannes		●				
Chlamys praescabriusculus catalaunicus Almera and Bofill		●				
Chlamys scabrella tarraconensis Almera and Bofill		●				
Chlamys sub-holgeri Fontannes		●				
Pecten convexior Almera and Bofill		●				
Flabellipecten expansus Sowerby		●				
Chlamys zitteli Fuchs		●				
Chlamys praescabriusculus talarensis Kilian		●				
Chlamys varia interstriata Schaffer		●				
Chlamys radians combaluzieri Morgan		●				
Pecten pseudobeudanti Deperet and Roman		●				
Chlamys submalvinae Blanckenhorn		●	●			
Chlamys gentoni Fontannes		●	●			
Chlamys tournali De Serres		●	●			
Chlamys solarium Lamarck		●	●	●		
Chlamys latissima nodosiformis Fuchs		●	●	●		
Amussium cristatum badense Fontannes		●	●	●		
Chlamys haueri Michelotti		●	●	●		
Flabellipecten fraterculus Sowerby		●	●	●	●	
Chlamys radians Nyst		●	●	●	●	

	Aquitanian	Burdigalian	Helvetian	Tortonian	Pliocene	Recent
LAMELLIBRANCHS						
Flabellipecten costisulcatus Almera and Bofill		●	●	●	●	
Pecten aduncus Eichwald			●			
Chlamys jakloweciana Kittl			●	●		
Chlamys malvinae Dubois			●	●		
Pecten dunkeri Mayer-Eymar			●	●		
Pecten praebenedictus Tournouër			●	●		
Chlamys melii Ugolini			●	●	●	
Chlamys multistriata simplicula Sacco			●	●	●	
Flabellipecten flabelliformis Brocchi			?	●	●	
Chlamys bollonensis Mayer-Eymar					●	
Chlamys varia strangulata Locchi					●	
Chlamys opercularis laticostata Monterosato					●	
Flabellipecten astensis Sacco					●	
Chlamys pes-felis (Linné)					●	
Amussium cristatum Bronn					●	
**Ostraea gingensis* Schlotheim		●				
Ostraea crassicostata Hoernes		●				
Ostraea barroisi Kilian		●				
Ostraea velaini (Munier-Chalmas) Kilian		●				
ECHINOIDS						
Clypeaster intermedius Desmoulins		●				
Clypeaster scillae Desmoulins		●				
Clypeaster grandiflorus Bronn		●				
Clypeaster latirostris Agassiz		●				
Clypeaster ludovice-salvatoris Lambert		●				
Clypeaster portentosus Desmoulins		●				
Prenaster falloti Lambert		●				

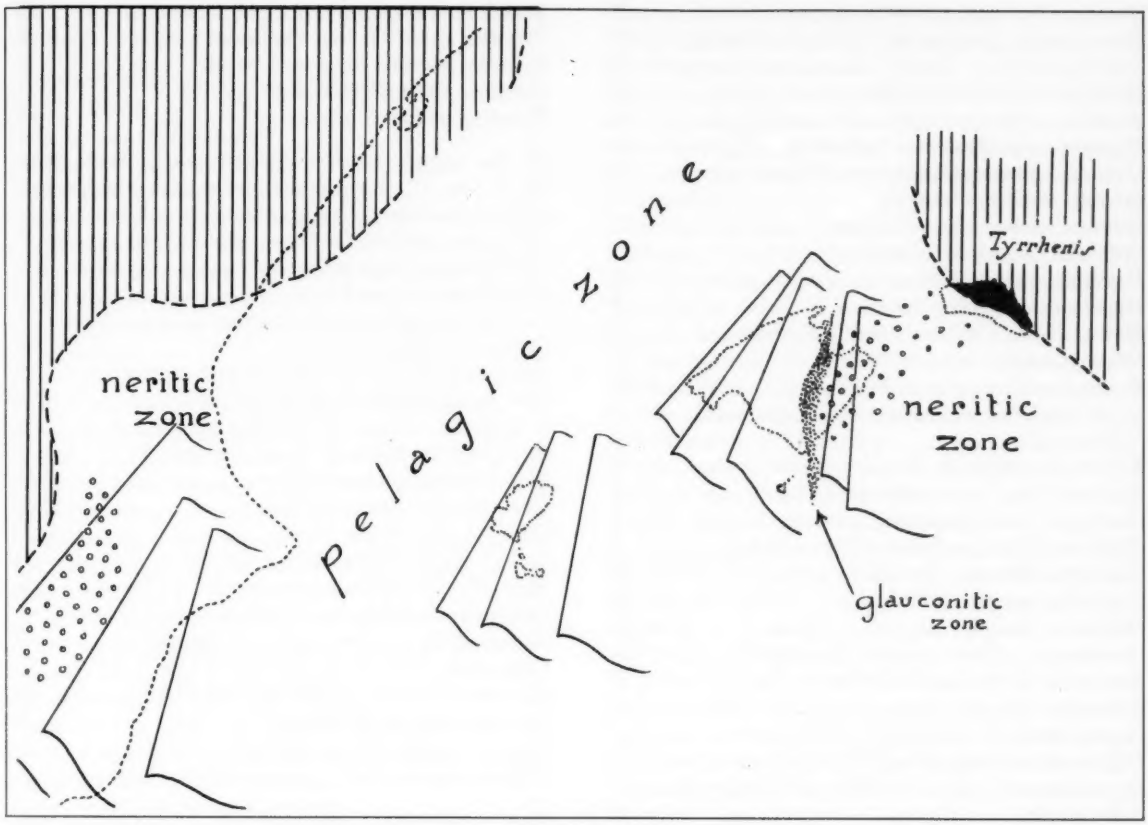
* Distribution in the Balearics only.

MIOCENE MICROFAUNAS OF THE BALEARICS

Within the stratigraphic succession of the Burdigalian transgression (text-fig. 3), microfaunas of foraminifera make their appearance in the following manner: The lower, strongly detrital levels are barren, but great numbers of *Operculina complanata* Defrance and numerous *Amphistegina lessonii* d'Orbigny appear in the higher, finer-grained arenaceous beds. Heterosteginas abound in the zoogenous limestone beds, but because it is impossible to extract them, their specific identity has not been determined. They are particularly common in the eastern zone (text-fig. 3, nos. 3–5). The great banks of zoogenous limestones are filled with countless remains of littoral organisms, transported and intensely triturated, and constituting a vast thanatocoenosis.

Miogypsina mediterranea Bronnimann appears in the detrital beds of sandstone at the base of the transgressive series, extending to the higher beds of limestone and zoogenous limestone. In the eastern zone it persists into the highest levels (text-fig. 3, no. 5); in the central and Sierra Norte zones it is rather common in the basal levels of the marly sandstone series. Its distribution in the deposits of the Burdigalian of Majorca can be defined as indicated in text-figure 3, no. 8, that is to say, linked with shallow biotopes. Whenever specimens could be extracted or well-oriented slides could be prepared, they have all proved to belong to Bronnimann's species.

With increase in the depth of deposition in the central and Sierra Norte zones during the upper-



TEXT-FIGURE 4

Paleogeographic reconstruction of the Balearic area during the Burdigalian, showing the positions of the three folded zones of Iviza (pelagic facies) and of Majorca (pelagic zone in white; glauconitic zone and neritic zone). The vertical lines indicate emergent land.

most Burdigalian, the sedimentation became increasingly finer and of a more pelagic nature, with a prevalence of marly deposits. These are easy to break down, and yield microfaunas in a perfect state of preservation. In the lowest of the marly sandstone beds (text-fig. 3, no. 4), the following species, most of which are arenaceous, predominate:

Bolivinoides bronniana (d'Orbigny)	VR
Chrysalogonium longicostatum Cushman and Jarvis	A
Cibicides barnetti Bermudez	A
Cylindroclavulina bradyi (Cushman)	F
Elphidium crispum (Linné)	F
Gypsina globulus (Reuss)	F
Karreriella chilostoma (Reuss)	A
Karreriella subcylindrica (Nuttall)	A
Nodosarella subnodosa (Guppy)	F
Nodosaria lamellata Cushman and Stainforth	A
Planulina renzi Cushman and Stainforth	A
Recurvoides deformis (Andreae)	A
Schenckiella karreri (Cushman)	R
Stilostomella paucistriata (Galloway and Morrey)	F
Stilostomella subspinosa Cushman	F
Textularia deyaensis Colom	VR
Textularia digitata d'Orbigny	F
Textularia lanceolata (Karrer)	F
Textularia nussdorfensis d'Orbigny	VR
Textularia rugosa (Reuss)	VR
Textularia soldanii Fornasini	VR
Uvigerina rustica Cushman and Edwards	A
Vulvulina pectinata Hantken	F

In higher strata of these same marly sandstones, the number of species increases. The majority of the species listed above are found here, together with the following forms:

Ammobaculites bujosensis Colom	R
Anomalinoides pompilioides (Galloway and Heminway)	A
Bulimina socialis Bornemann	R
Bulimina tuxpamensis Cole	A
Chrysalogonium elongatum Cushman and Jarvis	A
Cibicides cicatricosus maioricensis Colom	F
Cibicides mexicanus Nuttall	A
Cibicides subtenuissimus (Nuttall)	F
Cibicidina cushmani (Nuttall)	R
Dentalina emaciata Reuss	R
Dentalina reussi Neugeboren	A
Dorothia brevis Cushman and Stainforth	A
Ellipsoglandulina exponens (Brady)	R
Ellipsoglandulina labiata (Schwager)	R
Ellipsoglandulina multicostata (Galloway and Morrey)	F
Ellipsoidina ellipsoides abbreviata Seguenza	F
Gaudryina lapugyensis maioricensis Colom	F
Gaudryina (*Pseudogaudryina*) *gymnesica* Colom	F
Gaudryina (*Siphogaudryina*) *balearica* Colom	F
Glandulina dimorpha (Bornemann)	R
Glandulina laevigata d'Orbigny	F
Glandulina laevigata subcylindrica Reuss	R
Gyroidinoides soldanii nitidula (Schwager)	F
Karreriella hantkeniana Cushman	R
Karreriella siphonella (Reuss)	F
Lagena ornaticollis Colom	F
Lagenonodosaria longiscata (d'Orbigny)	F
Lagenonodosaria spinicosta adelinensis Palmer and Bermudez	R
Marginulinopsis murex (Batsch)	VR
Martinottiella communis (d'Orbigny)	R
Nodosarella mappa (Cushman and Jarvis)	R
Nodosaria flintii Cushman	VR
Orthomorphina rohri Cushman and Stainforth	R
Osangularia mexicana (Cole)	A
Planulina marielana Hadley	F
Pleurostomella acuta Hantken	F
Pullenia bulloides d'Orbigny	VR
Pullenia quinqueloba (Reuss)	R
Pullenia salisburyi R. E. Stewart and K. C. Stewart	VR
Robulus alatolimbatus (Gümbel)	F
Robulus antipodum (Stache)	R
Robulus articulatus (Reuss)	R
Robulus duracina (Stache)	F
Robulus nuttalli Cushman and Renz	R
Robulus semiimpressus (Reuss)	R
Schenckiella karreri (Cushman)	R
Sigmoilinopsis celata (Costa)	F
Sphaeroidina bulloides d'Orbigny	F
Sphaeroidina variabilis Reuss	VR
Stilostomella modesta (Bermudez)	F
Stilostomella recta (Palmer and Bermudez)	F
Textulariella barretti (Jones and Parker)	F
Vulvulina sp. cf. *V. colei* Cushman	F
Vulvulina pectinata mexicana Nuttall	F
Vulvulina pennatula (Batsch)	A
Vulvulina spinosa Cushman	R

In the uppermost fine-grained marly beds (text-fig. 3, no. 7), the predominance of a globigerinid facies is manifest. The planktonic species are:

Globigerina altispira Cushman and Ellisor	R
Globigerina bulloides d'Orbigny	VR
Globigerina concinna Reuss	VR
Globigerina conglomerata Schwager	A
Globigerina diplostoma Reuss	VR
Globigerina dissimilis Cushman and Bermudez	R
Globigerina elongata d'Orbigny	VR
Globigerinella hirsuta (d'Orbigny)	R
Globigerinoides bispherica Todd, emend. Blow	R
Globigerinoides glomerosa Blow	VR
Globigerinoides transitoria Blow	R
Globigerinoides triloba (Reuss)	A
Globigerinoides triloba forma *irregularis* LeRoy	R
Globigerinoides triloba forma *sacculifera* (Brady)	R
Globigerinoides triloba forma *trilocularis* (d'Orbigny)	F
Globoquadrina quadraria advena Bermudez	R
Globorotalia fohsi (Cushman and Ellisor)	VR
Globorotalia mayeri (Cushman and Ellisor)	VR
Orbulina universa d'Orbigny	R
Orbulina universa forma *bilobata* (d'Orbigny)	R
Orbulina universa forma *suturalis* Bronnimann	F

The predominant globigerinid is *Globigerina conglomerata*, together with *Globigerinoides triloba* and its derived forms. I have been able to identify three of Blow's species; the others are doubtful. *Globorotalia fohsi* has been identified, but it is very rare, and unlike its companion, *Globorotalia mayeri*, does not pass into the Helvetian. *Globigerina dissimilis* is irregularly distributed. Both this species and *Globorotalia fohsi* give the impression of being about to disappear at the close of the Burdigalian.

As the globigerinid sedimentation grows more pure, the following species become more frequent:

Cassidulina carandelli Colom	VR
Cassidulina havanensis Cushman and Bermudez	F
Cassidulina margareta Karrer	R
Cassidulina subglobosa horizontalis Cushman and Renz	A
Chilostomelloides ovicula Nuttall	R
Eggerella bradyi (Cushman)	A
Ehrenbergina cubensis pollentianensis Colom	R
Gyroidinoides soldanii nitidula (Schwager)	F
Karreriella bradyi (Cushman)	F
Laticarinina pauperata (Parker and Jones)	F
Siphonina bradyana burdigalensis Colom	A

The following assemblage is more or less rich and constant as depths increase:

Anomalina flintii spissiformis Cushman and Stainforth ..... R
Bolivina alata (Seguenza) ..... R
Bolivina arta Macfadyen ..... R
Bolivinopsis carinata (d'Orbigny) ..... VR
Bulimina alsatica Cushman and Parker ..... F
Bulimina alazanensis Cushman ..... R
Chrysalogonium asperum Cushman and Stainforth R
Chrysalogonium elongatum Cushman and Jarvis.. F
Chrysalogonium tenuicostatum Cushman and Bermudez ..... VR
Cibicides haidingeri (d'Orbigny) ..... VR
Cibicides mundulus (Brady, Parker and Jones)... VR
Cibicides nucleatus (Seguenza) ..... VR
Cibicides praecinctus (Karrer) ..... VR
Cibicides pseudoungerianus Cushman ..... VR
Cibicides robertsonianus (Brady)..... VR
Dentalina alazanensis (Nuttall) ..... R
Dentalina cooperensis Cushman ..... F
Dentalina mucronata Neugeboren ..... R
Dorothia burdigalensis Colom ..... F
Elphidium subplanatum Cushman ..... F
Eponides schreibersii (d'Orbigny) ..... VR
Eponides umbonatus multisepta Koch ..... R
Eponides vortex Galloway and Heminway ..... F
Globobulimina glabra Cushman and Parker .... VR
Lagena globosa spinulosa (Reuss)..... VR
Lagena orbignyana alata Cushman ..... A
Lagena orbignyana elliptica Cushman ..... F
Lagena pulcherrima enitens (Cushman and Stainforth) ..... R
Lingulina costata d'Orbigny ..... VR
Lingulina ponceana Galloway and Heminway .. R
Lingulina seminuda Hantken..... R
Loxostoma limbatum (Brady) ..... F
Marginulina nuttalli Todd and Kniker ..... R
Marginulina nuttalli jordai Colom..... A
Nodosarella mappa (Cushman and Jarvis) ..... F
Nodosarella robusta Cushman ..... F
Nodosarella tuckerae Hadley ..... F
Nodosaria acuminata Hantken ..... VR
Nodosaria pyrula d'Orbigny ..... R
Nodosaria pyrula semirugosa d'Orbigny..... VR
Nodosaria soluta Bornemann ..... VR
Nodosaria spinulosa (Montagu) ..... F
Nodosaria stainforthi Cushman and Renz ..... VR
Orthomorphina challengeriana (Thalmann) ..... VR
Orthomorphina rohri (Cushman and Stainforth) . VR
Planularia dentata Hantken..... F
Planularia galea peneroplea Dervieux ..... R
Planularia hantkeni Rzehak ..... R
Planulina dohertyi (Galloway and Morrey)..... VR
Plectofrondicularia alazanensis (Cushman) ..... F
Plectofrondicularia deyaensis Colom ..... A
Plectofrondicularia inaequalis (Costa)..... VR
Plectofrondicularia morreyae Cushman ..... VR
Pleurostomella alternans Schwager ..... R
Pleurostomella bierigi Palmer and Bermudez.... F
Pleurostomella bierigi hebeta Cushman and Stainforth ..... F
Pleurostomella brevis Schwager ..... F
Pleurostomella nuttalli Cushman and Jarvis..... VR
Rectuvigerina multicostata optima (Cushman) .... F
Rectuvigerina seriata (Cushman) ..... A
Robulus alazanensis (Cushman) ..... R
Robulus budensis (Hantken) ..... R
Robulus clericii (Fornasini) ..... F
Robulus clericii acies Cushman and Renz ..... F
Robulus crassus (d'Orbigny) ..... F
Robulus kubinyi (Hantken) ..... VR
Robulus subpapillosus (Nuttall) ..... F
Robulus vortex (Fichtel and Moll) ..... F
Saracenaria cymboides (d'Orbigny) ..... VR
Schenckiella cyclostomata (Galloway and Morrey) VR
Stilostomella nuttalli gracillima (Cushman and Jarvis) ..... R
Stilostomella verneuili (d'Orbigny) ..... A
Uvigerina barbatula Macfadyen ..... R
Uvigerina flintii Cushman..... F
Vaginulina badenensis d'Orbigny ..... F
Vaginulina badenensis neugeboreni Rzehak ..... VR
Vaginulina pseudoclavata Colom ..... A
Valvulineria palmarealensis (Nuttall) ..... R
Vulvulina pennatula (Batsch) ..... F
Vulvulina pennatula italica Cushman ..... F
Vulvulina stainforthi Cushman and Renz ..... R

In the uppermost marly biotopes (text-fig. 3, no. 7), of greatest depth and purely globigerinid character, species typical of this environment appear simultaneously. They are:

Astrorhiza cf. *furcata* Goës ..... VR
Cyclammina deformis (Guppy)..... R
Dorothia burdigalensis Colom ..... A
Laticarinina pauperata (Parker and Jones) ..... F
Lingulina ponceana (Galloway and Heminway) R
Lingulina seminuda Hantken ..... R
Rhabdammina abyssorum M. Sars ..... F
Technitella legumen Norman ..... F
Tritaxilina balearica Colom ..... F
Tritaxilina pleionensis Cushman ..... R

There is also a greater abundance of Lagenidae (*Dentalina*, *Nodosaria*, *Robulus*, etc.). These species are never very abundant, however, and I believe that the higher globigerinid deposits were not laid down at depths of more than 500–600 meters. In

most cases the depth of deposition of the middle horizons, from which a large part of the forms listed above came, did not exceed some 300 meters. Very few of these species extend into the Helvetian, but the majority of the forms mentioned are found in the "Upper Oligocene"–Lower Miocene deposits of Central America. I believe that in Majorca they represent Burdigalian levels because of their coexistence with the groups of lamellibranchs and large Clypeasters cited above, and also because similar associations are repeated in North Africa in the Lower Miocene (Lacoste and Rey, 1939; Ostrowsky, 1939; Rey, 1954) and in the Langhian (= Burdigalian) of Italy, according to recent studies by di Napoli (1953), Ruscelli (1953, 1956), and others.

Further analysis of the whole list of species cited produces the following results: (1) One group of species could be called "European" or "Mediterranean"; they have long been known, and their types come from the Upper Oligocene or Lower Miocene of Hungary, Austria, or Italy. These species are:

Amphistegina lessonii d'Orbigny
Bolivina alata Seguenza
Bolivina arta Macfadyen
Bolivina scalprata miocenica Macfadyen
Bulimina alsatica Cushman and Parker
Dentalina emaciata Reuss
Dentalina mucronata Neugeboren
Dentalina reussi Neugeboren
Elphidium subplanatum Cushman
Glandulina dimorpha (Bornemann)
Gyroidinoides soldanii nitidula (Schwager)
Haplophragmoides latidorsatus (Bornemann)
Karreriella chilostoma (Reuss)
Karreriella gaudryinoides (Fornasini)
Karreriella hantkeniana Cushman
Lagenonodosaria longiscata (d'Orbigny)
Lingulina costata d'Orbigny
Lingulina seminuda Hantken
Marginulinopsis murex (Batsch)
Martinottiella communis (d'Orbigny)
Nodosaria acuminata Hantken
Nodosaria spinulosa (Montagu)
Nonion affinis (Reuss)
Nonion soldanii Fornasini
Pleurostomella acuta Hantken
Pleurostomella alternans Schwager
Pleurostomella brevis Schwager
Recurvoides deformis (Andreae)
Saracenaria acutauricularis (Fichtel and Moll)
Schenckiella karreri (Cushman)
Stilostomella verneuili (d'Orbigny)
Textularia concava (Karrer)
Textularia digitata d'Orbigny
Textularia lanceolata (Karrer)
Textularia nussdorfensis d'Orbigny
Textularia soldanii Fornasini
Tritaxilina pleionensis Cushman
Uvigerina barbatula Macfadyen
Vaginulina badenensis d'Orbigny
Vaginulina badenensis neugeboreni Rzehak
Vulvulina pectinata Hantken
Vulvulina pennatula (Batsch)
Vulvulina pennatula italica Cushman

(2) Other species were first described by American authors from American deposits; the majority of them were believed to be from "Oligocene" levels, and the rest from the Lower Miocene. This association corresponds well with the *Globorotalia fohsi* zone of the Caribbean area. These species are:

Anomalina flintii spissiformis Cushman and Stainforth
Anomalinoides pompilioides (Galloway and Heminway)
Bulimina alazanensis Cushman
Bulimina tuxpamensis Cole
Cassidulina havanensis Cushman and Bermudez
Cassidulina subglobosa horizontalis Cushman and Renz
Chilostomelloides ovicula Nuttall
Chrysalogonium asperum Cushman and Stainforth
Chrysalogonium elongatum Cushman and Jarvis
Chrysalogonium longicostatum Cushman and Jarvis
Chrysalogonium tenuicostatum Cushman and Bermudez
Cibicides barnetti Bermudez
Cibicides mexicanus Nuttall
Cibicides subtenuissimus (Nuttall)
Cibicidina cushmani (Nuttall)
Cylindroclavulina bradyi (Cushman)
Dentalina alazanensis (Nuttall)
Dorothia brevis Cushman
Ellipsoglandulina multicostata (Galloway and Morrey)
Eponides vortex Galloway and Heminway
Karreriella subcylindrica (Nuttall)
Lagena orbignyana alata Cushman
Lagena orbignyana elliptica Cushman
Lagena pulcherrima enitens Cushman and Stainforth
Lagenonodosaria spinicosta adelinensis Palmer and Bermudez
Lingulina ponceana (Galloway and Heminway)
Nodosarella mappa (Cushman and Jarvis)
Nodosarella robusta Cushman
Nodosarella tuckerae Hadley
Nodosaria lamellata Cushman
Nodosaria stainforthi Cushman
Orthomorphina challengeriana (Thalmann)
Osangularia mexicana (Cole)
Planulina dohertyi (Galloway and Morrey)
Planulina marialana Hadley

Planulina renzi Cushman and Stainforth
Plectofrondicularia alazanensis (Cushman)
Pleurostomella bierigi Palmer and Bermudez
Pleurostomella bierigi hebeta Cushman and Stainforth
Pleurostomella nuttalli Cushman and Jarvis
Rectuvigerina multicostata Cushman and Jarvis
Rectuvigerina multicostata optima (Cushman)
Rectuvigerina seriata (Cushman)
Robulus subpapillosus (Nuttall)
Schenckiella cyclostomata (Galloway and Morrey)
Siphogenerina transversa Cushman
Stilostomella modesta (Bermudez)
Stilostomella nuttalli gracillima Cushman and Jarvis
Stilostomella paucistriata (Galloway and Morrey)
Stilostomella recta (Palmer and Bermudez)
Stilostomella subspinosa (Cushman)
Uvigerina flintii Cushman
Uvigerina rustica Cushman and Edwards
Valvulineria palmarealensis (Nuttall)
Vulvulina stainforthi Cushman and Renz

(3) Finally, the Burdigalian of Majorca possesses a short series of species of its own:

Ammobaculites buiosensis Colom
Astacolus balearicus Colom
Astacolus burdigalensis Colom
Cassidulina carandelli Colom
Cibicides cicatricosus maioricensis Colom
Cibicides floridanus burdigalensis Colom
Dorothia burdigalensis Colom
Ehrenbergina cubensis pollentianensis Colom
Gaudryina lapugyensis maioricensis Colom
Gaudryina (Pseudogaudryina) rhodiensis Cushman
Lagena castrensis transversostriata Colom
Lagena montuiriensis Colom
Lagena ornaticollis Colom

Lagena (Reussoolina) burdigalensis Colom
Marginulina balearica Colom
Marginulina binisalemensis Colom
Marginulina nuttalli jordai Colom
Nodosarella balearica Colom
Orthomorphina nodulosostriata Colom
Plectofrondicularia deyaensis Colom
Rotalia darderi Colom
Textularia deyaensis Colom
Tritaxilina balearica Colom
Vaginulina pseudoclavata Colom

Some of these species have been found recently in North Africa (Magné, 1953*b*, 1955*a*, *b*,). The "Caribbean" species are found mixed with the forms listed above and with the "European" and "Mediterranean" species in the Balearic Islands, and *Miogypsina mediterranea* occurs together with all of them.

Such species as *Rectuvigerina multicostata*, *Rectuvigerina transversa*, and *Globorotalia fohsi* and its varieties have long been held to be characteristic of the "Oligocene" by American micropaleontologists. Renz considered *Rectuvigerina multicostata* as Miocene, and Bermudez likewise believed *Globorotalia fohsi* to be Miocene, but both of these authors later modified their opinions. Nevertheless, their first supposition appears well founded, as far as the stratigraphic position of these species in the Balearics is concerned. There is no doubt that a considerable number of species which are held to be "Upper Oligocene" in Central America are found in Majorca in Lower Miocene beds.

A small group of species from the Burdigalian deposits of Majorca represent, in my opinion, the survivors of more primitive associations, chiefly Upper Eocene or Oligocene of Central America and of Europe, which continued to exist, although in small numbers, up to the Lower Miocene, when they disappeared. The most interesting are:

Bulimina alazanensis Cushman
Bulimina socialis Bornemann
Bulimina tuxpamensis Cole
Cassidulina havanensis Cushman and Bermudez
Cibicides mexicanus Nuttall
Cibicides subtenuissimus (Nuttall)
Chrysalogonium tenuicostatum Cushman and Bermudez
Dentalina alazanensis (Nuttall)
Globigerina dissimilis Cushman and Bermudez
Nodosarelle tuckerae Hadley
Nodosarella salmojraghii Martinotti
Orthomorphina rohri (Cushman and Stainforth)
Osangularia mexicana (Cole)
Plectofrondicularia alazanensis (Cushman)
Pleurostomella brevis (Schwager)
Vulvulina colei Cushman
Vulvulina pectinata (Hantken)
Vulvulina stainforthi Cushman and Renz

The following species, which are rare in the Burdigalian, become prevalent in the Helvetian:

Bolivina alata (Seguenza)
Bolivinopsis carinata (d'Orbigny)
Cibicides haidingeri (d'Orbigny)
Cibicides nucleatus (Seguenza)
Cibicides praecinctus (Karrer)
Dentalina emaciata Reuss
Eponides schreibersii (d'Orbigny)
Globigerina altispira Cushman and Jarvis
Globigerina diplostoma Reuss
Lagenonodosaria longiscata (d'Orbigny)
Lingulina costata d'Orbigny
Marginulinopsis murex (Batsch)

Nodosaria soluta Bornemann
Plectofrondicularia inaequalis (Costa)
Vaginulina badenensis d'Orbigny

Given these foraminiferal populations and their stratigraphic positions, as well as the environments in which they developed, is it possible to consider them Helvetian, even though they contain *Miogypsina mediterranea*? To me it does not seem feasible, but it does seem evident that they all show close relationships with those of the Upper Oligocene or the Lower Miocene of Europe or of Central America. The difficulty lies in defining them as Upper Oligocene or as Burdigalian. On the other hand, their distinction from the Helvetian foraminifera of the Mediterranean region seems clear. Other students will now be able to make use of the data given here for comparisons between these sediments and microfaunas and those of other localities. Very few of the Burdigalian species pass into the Helvetian, and this significant fact is attributable in great part to the existence of the Helvetian transgression, which destroyed all continuity between the associations of the Burdigalian and those of the Helvetian–Tortonian, for the latter transgression, as happens in such cases, brought with it a whole new assemblage of Mediterranean Upper Miocene species. Those of the Burdigalian became extinct or migrated toward southern seas, where some of them still continue to exist.

As for the Helvetian foraminifera of Majorca, those of the central and northeastern zones of the island indicate littoral biotopes, but those of the southwestern region indicate a gradual increase in depth. The deep-sea zones of the Helvetian sea were situated southwest of the present Bay of Palma (text-fig. 1).

The predominant planktonic species in the Helvetian are *Globigerinoides triloba* (Reuss) and three of its forms, *trilocularis*, *sacculifera* and *immatura*. Other globigerinids are rare, even *Globigerina diplostoma* Reuss, which begins to be very abundant in the Upper Miocene. The same occurs with *Globigerinella hirsuta* (d'Orbigny) and *Globigerina elongata* d'Orbigny. The first is a much debated form, considered by many authors to be synonymous with *Globigerinella aequilateralis* (Brady). The Majorcan specimens can be referred to d'Orbigny's species, with which they agree in their small size, tightly closed spire, and spinosity, which is visible in a fairly large number of sp cimens. *Globigerina altispira* is extremely rare. Orbulines (*Orbulina universa* and *Orbulina universa bilobata*) are frequent (see Table 2).

TABLE 2

VERTICAL DISTRIBUTION OF PLANKTONIC SPECIES IN THE MIOCENE OF MAJORCA

	Burdigalian	Helvetian–Tortonian
Globigerina dissimilis Cushman and Bermudez	A	
Globigerina conglomerata Schwager	R	
Globorotalia fohsi (Cushman and Ellisor)	VR	
Globoquadrina quadraria advena Bermudez	R	
Pullenia salisburyi Stewart and Stewart	VR	
Globigerina elongata (d'Orbigny)	VR	R
Globigerina altispira Cushman and Jarvis	VR	R
Globigerina bulloides d'Orbigny	R	R
Globigerina diplostoma Reuss	VR	R
Globigerinoides transitoria (Blow)	F	R
Globigerinoides glomerosa (Blow)	VR	VR
Globigerinoides triloba (Reuss)	A	A
Globigerinoides bispherica Todd, emend. Blow	R	R
Globigerinoides triloba forma *trilocularis* (d'Orbigny)	F	F
Globigerinoides triloba forma *immatura* LeRoy	VR	A
Globigerinoides triloba forma *sacculifera* (Brady)	VR	F
Globigerinoides triloba forma *irregularis* LeRoy	VR	R
Globigerinella hirsuta (d'Orbigny)	VR	R
Globorotalia mayeri (Cushman and Ellisor)	R	VR
Orbulina universa d'Orbigny	R	A
Orbulina universa bilobata (d'Orbigny)	R	F
Globigerinoides triloba sacculifera forma *recumbens* Rhumbler		VR
Globigerinoides triloba sacculifera forma *galeata* Rhumbler		VR
Globorotalia hirsuta (d'Orbigny)		R
Globorotalia menardii (d'Orbigny)		VR
Sphaeroidinella n. sp.		F

A: Abundant R: Rare
F: Frequent VR: Very rare

Globorotalia menardii is found only in the Helvetian–Tortonian in Majorca, a proof of the more recent age of these formations.

In zones of purely globigerinid deposition, the following species are abundant:

Cassidulina laevigata carinata Cushman
Cassidulinoides bradyi (Norman)
Chilostomella ovoidea Reuss
Eggerella bradyana (Cushman)
Frondicularia inaequalis (Costa)
Karreriella bradyana (Cushman)
Planodiscorbis rarescens (Brady)
Pseudoeponides tener (Brady)
Siphonina plano-convexa Silvestri

Uvigerina, *Bolivina* and large numbers of *Robulus* and *Dentalina* also occur. In the northeastern zone, with its littoral biotopes, *Peneroplis*, *Planorbulina mediterranensis* d'Orbigny, *Cibicides lobatulus* (Walker and Jacob), *Quinqueloculina lamarckiana* d'Orbigny, and *Elphidium crispum* ssp. *biniacoense* Colom appear, indicating the existence of wide, very shallow fields of algae. In general, *Cibicides haidingeri* and *Cibicides praecinctus*, together with their flattened forms named *depressa* by Lipparini, are extraordinarily abundant in all the deposits.

The foraminifera of the following general list come from diverse biotopes of the Helvetian transgression. Those marked + are also found in the Burdigalian.

+*Amphistegina lessonii* d'Orbigny ..... F
Bigenerina compressissima Colom ..... F
Bigenerina nodosaria textularioides (Goës) ..... F
Bolivina aenariensis (Costa) ..... R
+*Bolivina alata* (Seguenza) ..... F
Bolivina antiqua d'Orbigny..... VA
Bolivina catanensis Seguenza ..... VA
Bolivina scalprata miocenica Macfadyen ..... F
Bolivina scalprata retiformis Cushman ..... F
+*Bolivinopsis carinata* (d'Orbigny) ..... A
Bulimina buchiana d'Orbigny ..... F
Bulimina elongata subulata Cushman and Parker ..... VA
Bulimina pupoides d'Orbigny ..... F
Cancris auricula (Fichtel and Moll) ..... R
Cassidulina laevigata carinata Cushman ..... F
Cassidulinoides bradyi (Norman) ..... F
Chilostomella ovoidea Reuss ..... R
Cibicides floridanus miocenicus Colom..... F
+*Cibicides haidingeri* (d'Orbigny) ..... VA
+*Cibicides lobatulus* (Walker and Jacob) ..... F
+*Cibicides praecinctus* (Karrer) ..... VA
+*Cylindroclavulina bradyi* (Cushman) ..... A
Dendritina elegans d'Orbigny ..... VR
Dentalina catenulata Reuss..... F
Dentalina crassicauda Seguenza..... R
Dentalina emaciata Reuss..... R
Dentalina filiformis d'Orbigny ..... F
Dentalina inornata d'Orbigny ..... F
Dentalina pauperata d'Orbigny ..... R
Dimorphina tuberosa d'Orbigny ..... F
Discorbis bertheloti (d'Orbigny) ..... F
Dorothia gibbosa (d'Orbigny) ..... A
+*Eggerella bradyi* (Cushman) ..... R
+*Elphidium crispum* (Linné) ..... R
Elphidium crispum biniacoense Colom ..... A
+*Eponides schreibersi* (d'Orbigny) ..... R
Eponides tener (Brady)..... VR
+*Eponides umbonatus* (Reuss) ..... R
Frondicularia complanata Defrance ..... F
+*Frondicularia inaequalis* Costa ..... VA
Glandulina laevigata occidentalis Cushman .... R
Glandulina laevigata ovata Cushman and Applin R
Globulina gibba d'Orbigny ..... F
Globulina gibba fissicostata Cushman and Ozawa F
Globulina gibba myristiformis (Williamson)... F
Globulina gibba tuberculata d'Orbigny ..... F
Guttulina irregularis (d'Orbigny) ..... R
Guttulina problema d'Orbigny ..... F
Gyroidinoides soldanii (d'Orbigny) ..... R
Gyroidinoides soldanii nitidula (Schwager) .... R
Heterostegina costata d'Orbigny ..... R
Hopkinsina bononiensis (Fornasini) ..... F
Hoeglundina miocenica Hofker ..... VR
Karreriella badenensis (Reuss) ..... F
+*Karreriella bradyi* (Cushman) ..... F
Lagena semistriata Williamson ..... R
Lagena striata (d'Orbigny) ..... R
Lagenonodosaria adolphina (d'Orbigny) ..... F
Lagenonodosaria hispida (d'Orbigny) ..... A
Lagenonodosaria hispida aculeata (d'Orbigny) . A
+*Lagenonodosaria longiscata* (d'Orbigny) ..... F
+*Lagenonodosaria ovicula* (d'Orbigny) ..... F
Lagenonodosaria scalaris (Batsch) ..... F
Marginulina dubia Neugeboren ..... R
Marginulina subbullata Hantken..... F
Marginulinopsis costata (Batsch) ..... F
Marginulinopsis costata coarctata Silvestri ..... VA
+*Marginulinopsis murex* (Batsch)..... F
+*Martinottiella communis* (d'Orbigny) ..... F
Martinottiella communis perparva Cushman ... F
Nodosaria bacillum Defrance ..... A
+*Nodosaria flintii* Cushman..... R
+*Nodosaria soluta* Bornemann ..... R
Nodosaria vertebralis (Batsch) ..... VR
Nodosaria vertebralis albatrossi Cushman ..... VA
Nonion boueanum (d'Orbigny) ..... R
Nonion granosum (d'Orbigny) ..... R
Nonion ibericum Cushman ..... VR
Nonion politum (d'Orbigny) ..... VR
Nonion pompilioides (Fichtel and Moll) ..... F
Nonion scapha (Fichtel and Moll) ..... F
Nonion soldanii d'Orbigny ..... VR
Nubecularia lucifuga Defrance ..... VR
Peneroplis laevigatus Karrer..... VR
Peneroplis pertusus (Forskål) ..... F
Peneroplis planatus (Fichtel and Moll)..... R
Planorbulina mediterranensis d'Orbigny..... R
Planodiscorbis rarescens (Brady)..... R
Planularia cassis cassis Silvestri ..... F
Planularia cassis soldanii Silvestri ..... F
Planularia elongata (Montfort) ..... R
Planularia galea ovalis Dervieux ..... R
Planularia laevis Seguenza ..... F
Planulina ornata d'Orbigny ..... A

Plectofrondicularia angusticostata Cushman	R
Quinqueloculina sp. cf. *Q. lamarckiana* d'Orbigny	R
Ramulina globulifera Brady	F
Reussella spinulosa (Reuss)	R
Robulus americanus Cushman	VR
Robulus ariminensis (Seguenza)	F
Robulus calcar (Linné)	VA
Robulus calcar multispinatus Colom	A
+*Robulus clericii* (Fornasini)	F
Robulus costatus (Fichtel and Moll)	R
Robulus crassus (d'Orbigny)	R
Robulus cultratus (Montfort)	F
Robulus duracina (Stache)	F
Robulus echinatus (d'Orbigny)	F
Robulus gibbus (d'Orbigny)	F
+*Robulus iota* Cushman	R
Robulus nitidus (Reuss)	R
Robulus peregrinus (Schwager)	F
Robulus rotulatus (Lamarck)	R
+*Robulus septentrionalis* Cushman	F
Robulus vitreus (Seguenza)	F
Robulus vortex (Fichtel and Moll)	R
Saracenaria cymboides d'Orbigny	VR
Saracenaria latifrons (Brady)	F
Schenckiella bradyana Cushman	R
Schenckiella occidentalis (Cushman)	F
Schenckiella primaeva (Cushman)	R
+*Sigmoilopsis celata* (Costa)	A
+*Siphogenerina multicostata* Cushman and Jarvis	R
Siphonina plano-convexa (Silvestri)	A
Streblus beccarii (Linné)	R
Textularia articulata d'Orbigny	F
Textularia concava Karrer	R
Textularia consecta d'Orbigny	F
Textularia palmata Costa	A
+*Textularia rugosa* (Reuss)	F
Textularia sagittula d'Orbigny	VR
Textularia subangulata d'Orbigny	A
+*Uvigerina flintii* Cushman	R
Uvigerina pygmaea d'Orbigny	VA
Uvigerina rutila Cushman and Parker	VR
Vaginulinopsis inversa carinata Silvestri	F
Vaginulinopsis vindoboniensis Colom	F
Valvulineria bradyana (Fornasini)	F
Virgulina schreibersiana Czjzek	F
Vulvulina deperdita (d'Orbigny)	R

STRATIGRAPHIC CONCLUSIONS

The Helvetian–Tortonian associations of Majorca and Iviza differ distinctly from those of the Burdigalian of these islands. The great majority of the Helvetian–Tortonian species, however, are identical with those of the Vienna Basin and Italy, and many of them extend to the Pliocene and Recent. The divergence in composition between the Burdigalian and the Helvetian–Tortonian associations is quite evident.

A similar state of affairs is found in Italy. Recent studies by di Napoli, Ruscelli and others confirm the presence in the Langhian (= Burdigalian) of Italy of the same species that occur in the Burdigalian of Majorca. In a general way, the associations of small foraminifera of the Aquitanian and Burdigalian in Italy are very similar, and are rich in "Upper Oligocene" and Lower Miocene "Caribbean" forms. This, as has already been pointed out, is also observed in the Balearic and Andalusian zones of Spain. Nothing similar, however, exists in the Vindobonian levels of Spain or of Italy.

The stratigraphic results obtained by Italian micropaleontologists in their country accord perfectly with those given in the present paper with reference to the distinction between Burdigalian and Helvetian–Tortonian levels. Therefore, many of the beds that contain *Miogypsina mediterranea*, with its accompanying smaller foraminifera that have long been held to be "Upper Oligocene" in Central America, may possibly be considered Lower Miocene (Burdigalian = Langhian) on both sides of the Atlantic. This is a logical conclusion when we note that the associations of this age reveal great uniformity of composition and are closely related, almost exclusively, to the beds of the Lower Miocene.

It is certain that *Globorotalia fohsi*, *Globigerina dissimilis*, and other "Caribbean" species occur in the Mediterranean Lower Miocene, but they appear to die out there. What future research may show I do not know, but to date I have not found them in the typical Helvetian beds of Majorca.

In a recent paper, Ruscelli (1956) cites such forms as *Nodosaria lamellata* Cushman and Stainforth, *Nodosaria stainforthi* Cushman and Bermudez, *Chrysalogonium tenuicostatum* Cushman and Bermudez, "*Marginulina* cf. *behmi* (Reuss)," and others among her lists of Helvetian species from the Mainica River, which, in my opinion, were not living when these beds were deposited, but represent reworked forms derived from older levels. The presence of *Marginulina behmi* Reuss in particular leads me to think so, for its presence in that level is most unusual. I have never found the first three species in the Helvetian of the Balearics, but they are frequent in the Burdigalian; this is also true in Italy. As for *Marginulina behmi* Reuss (= *Marginulinopsis infracompressa* Thalmann), it is characteristic of the Upper Eocene, and does not extend to the Burdigalian. In the Spanish Pyrenean region it is one of

the most typical species of the Upper Eocene (Colom, 1945*b*; Ruiz de Gaona and Colom, 1950).

In short, the stratigraphic column given by Ruscelli (1956, p. 51) agrees perfectly with what we find in Majorca and Iviza and throughout the Lower Miocene terrains of the North Betic Strait (Colom and Gamundi, 1951; Colom, 1952). But Miogypsinas have not been discovered to date in the well verified Helvetian–Tortonian of the Balearics and southeastern Spain. It must not be forgotten that, because the Helvetian is transgressive over the Burdigalian marls, many foraminifera of the latter age could have been redeposited in the Helvetian beds.

The main differences in composition between the Helvetian–Tortonian sediments of Majorca and those of the Aquitanian of southern Spain and of the Burdigalian of Majorca, Iviza and the North Betic Strait can be expressed as follows:

Helvetian–Tortonian of Majorca and of southeastern Spain	Lower sandstones with *Neoalveolina melo*; white molasse with neritic Vindobonian foraminifera. "Caribbean" species absent. Miogypsinas absent.
Burdigalian of Majorca and Iviza and of the North Betic Strait	Bluish and gray marls with sponge spicules and a calcareous and siliceous plankton. Great abundance of *Globigerina conglomerata* in the pelagic facies, and of *Miogypsina mediterranea* in the detrital ones. Many "Caribbean" foraminifera.
Aquitanian of southern Spain (North Betic Strait)	Bluish and gray marls with sponge spicules and a very rich calcareous and siliceous plankton. Many species of "Upper Oligocene" and Lower Miocene "Caribbean" foraminifera. Lepidocyclinas.

If the beds with *Miogypsina mediterranea* in the Balearics were Helvetian, to what age would the basal strata with *Neoalveolina melo* (Fichtel and Moll) and the molassic ones with *Ostraea crassissima* and the whole assemblage of foraminifera heretofore attributed to the Helvetian–Tortonian correspond? Inevitably, it seems to me, a Pliocene age would have to be accepted for them. The same would apply to Italy and other Mediterranean countries having identical Miocene lithotopes. Nevertheless, up to the present time, the existence of the marine Pliocene in the Balearics has not been demonstrated. It must be borne in mind that this stage is also discordant over earlier stages in the deposits of the Iberian peninsula. The beds with *Miogypsina mediterranea*, at least those of the Balearic area, are, in my opinion, Lower Miocene (Burdigalian = Langhian) in age.

BIBLIOGRAPHY

ARÈNES, J.
1951 – *Contribution à l'étude de la flore fossile burdigalienne des Baléares*. R. Soc. Española Hist. Nat., Bol., vol. 49, pp. 73–86.

ASCOLI, P.
1956 – *Microfaune della serie eocenica del Rio Repregoso e della serie oligocenica superiore di Mombisaggio-Mongariolo (Tortona-Alessandria)*. Riv. Ital. Pal. Strat., vol. 62, no. 3, pp. 153–196.

BRONNIMANN, P.
1940 – *Über die tertiären Orbitoididen und die Miogypsiniden von Nordwest-Marokko*. Schweiz. Pal. Abh., vol. 63 (1940–1942), art. 1, p. 94.

CITA, M. B.
1955 – *Paleogeografia del Terziario nella regione gardesana*. Riv. Ital. Pal. Strat., vol. 61, no. 3, pp. 137–161.

COLOM, G.
1945*a* *Los foraminíferos de "concha arenacea" de las margas burdigalienses de Mallorca*. Estud. Geol., no. 2, pp. 3–33.
1945*b* *Estudio preliminar de las microfaunas de foraminíferos de las margas eocenas y oligocenas de Navarra*. Estud. Geol., no. 2, pp. 35–84.
1946*a* *Los sedimentos burdigalienses de las Baleares*. Estud. Geol., no. 3, pp. 21–112.
1946*b* *Los foraminíferos de las margas vindobonienses de Mallorca*. Estud. Geol., no. 3, pp. 113–180.
1946*c* *La geología del Cabo Pinar, Alcudia (Mallorca)*. R. Soc. Española Hist. Nat., Bol., vol. extraord., pp. 361–389.
1951 – *Notas estratigráficas y tectónicas sobre la Sierra Norte de Mallorca*. R. Soc. Española Hist. Nat., Bol., vol. 49, no. 1–3, pp. 45–71.
1952 – *Aquitanian-Burdigalian diatom deposits of the North Betic Strait, Spain*. Jour. Pal., vol. 26, no. 6, pp. 867–885.
1956 – *Los foraminíferos del Burdigaliense de Mallorca*. R. Acad. Ciencias Artes Barcelona, Mem., vol. 32, no. 5, pp. 1–140, pls. 1–25.

COLOM, G., AND GAMUNDI, J.
1951 – *Sobre la extensión e importancia de las "moronitas" a lo largo de las formaciones aquitano-burdigalienses del estrecho Nort-Bético*. Estud. Geol., no. 14, pp. 331–385.

CONATO, V., AND MARTINIS, B.
1955 – *Osservazioni sul Miocene dei colli Veronesi e Vicentini*. Riv. Ital. Pal. Strat., vol. 61, no. 2, pp. 53–65.

CUSHMAN, J. A., AND RENZ, H. H.
1947 – *The foraminiferal fauna of the Oligocene, Ste. Croix formation of Trinidad, B.W.I.* Cushman Lab. Foram. Res., Spec. Publ., no. 22, pp. 1–46, pls. 1–8.

CUSHMAN, J. A., AND STAINFORTH, R. M.
1945 – *The foraminifera of the Cipero marl formation of Trinidad, B.W.I.* Cushman Lab. Foram. Res., Spec. Publ., no. 14, pp. 3–75, pls. 1–16.

DARDER, B.
1924 – *Sur l'âge des phénomènes de charriage de l'île de Majorque.* Acad. Sci., C. R., vol. 88.
1929 – *Le relief et la tectonique de Majorque.* Geol. Méditer. Occid., vol. 1, no. 2, Barcelona.

DROOGER, C. W.
1954*a* *Miogypsina in northern Italy; I–II.* K. Nederl. Akad. Wetensch., Proc., ser. B, vol. 57, no. 2, pp. 228–249.
1954*b* *Miogypsina in northwestern Morocco.* K. Nederl. Akad. Wetensch., Proc., ser. B, vol. 57, no. 5, pp. 580–591.
1954*c* *The Oligocene-Miocene boundary on both sides of the Atlantic.* Geol. Mag., vol. 91, no. 6, pp. 514–518.
1956 – *Transatlantic correlation of the Oligo-Miocene by means of foraminifera.* Micropaleontology, vol. 2, no. 2, pp. 183–192.

DROOGER, C. W., KAASSCHIETER, J. P., AND KEY, A. J.
1955 – *The microfauna of the Aquitanian-Burdigalian of southwestern France.* K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 21, no. 2, pp. 1–136, pls. 1–20.

FALLOT, P.
1922 – *Étude géologique de la Sierra de Majorque.* Paris: Librairie Polytechnique Ch. Beranger, 480 pp.

GIANOTTI, A.
1953 – *Microfaune della serie tortoniana del Rio Mazzapiedi-Castellania (Tortona-Alessandria).* Riv. Ital. Pal. Strat., Mem., no. 6, pp. 167–301.

GINO, G. F.
1953 – *Osservazioni geologiche sui dintorni di Sant'Agata Fossili (Tortona-Alessandria).* Riv. Ital. Pal. Strat., Mem., no. 6, pp. 7–23.

HERMITE, H.
1879 – *Études géologiques sur les îles Baléares; Partie I — Majorque et Minorque.* Paris: F. Savy, 357 pp.

HOERNES, R.
1905 – *Untersuchungen der jüngeren Tertiär-Ablagerungen des westlichen Mittelmeers.* K. Akad. Wiss. Wien, Sitzber., vol. 114, pp. 637–660, 737.

LACOSTE, J., AND REY, M.
1939 – *Sur l'âge et la répartition de certains faciès du Miocène dans le Prérif.* Soc. Géol. France, Bull., ser. 5, vol. 8 (1938), no. 5–6, pp. 305–320.

MAGNÉ, J.
1953*a* *Étude de la microfaune. In:* BERTRANIEU, J., AND MAGNÉ, J., *Le Miocène marin du revers septentrional du bassin du Hodna (partie orientale) (Département de Constantine, Algérie).* Soc. Géol. France, Bull., ser. 6 vol. 2 (1952), no. 4–6, pp. 275–282.
1953*b* *Les champs de pétrole des régions mésogéennes.* Congr. Géol. Internat., XIX, Alger, C. R., sec. 14, fasc. 16, p. 147.
1955*a* *In:* MAGNÉ, J., AND MATTAUER, M., *Découverte d'une unité "Miocène inférieur" dans l'allochtone tellien.* Algeria, Service Carte Géol., Bull., new ser., no. 5 (1954), pp. 235–247.
1955*b* *Microfaunes oligocènes dans la série "numidienne" de Petite Kabylie (Algérie).* Soc. Hist. Nat. Afrique du Nord, Bull., vol. 46, pp. 269–274.

NAPOLI ALLIATA, E. DI
1951 – *Considerazioni sulle microfaune del Miocene superiore italiano.* Riv. Ital. Pal. Strat., vol. 57, no. 4, pp. 91–119.
1953 – *Microfaune della parte superiore della serie oligocenica del Monte San Vito e del Rio Mazzapiedi-Castellania (Tortona-Alessandria).* Riv. Ital. Pal. Strat., Mem., no. 6, pp. 25–98.

NOLAN, H.
1895 – *Structure géologique d'ensemble de l'archipel Baléare.* Soc. Géol. France, Bull., vol. 23, pp. 76–91.

OSTROWSKY, V.
1939 – *Note préliminaire sur la répartition stratigraphique des petits foraminifères dans le Nummulitique du Prérif (Maroc).* Soc. Géol. France, Bull., ser. 5, vol. 8 (1938), no. 5–6, pp. 341–352.

REY, M.
1954 – *Comparaison des microfaunes du Nummulitique nord-marocain et du Nummulitique du golfe du Mexique et de la mer des Caraïbes.* Congr. Géol. Internat., XIX, Alger (1952), U.P.I., C. R., no. 19, pp. 39–60.

RUIZ DE GAONA, M., AND COLOM, G.
1950 – *Estudios sobre las sinecias de los foraminíferos eocénicos de la vertiente meridional del pirineo (Cataluña-Vizcaya).* Estud. Geol., no. 12, pp. 293–434.

RUSCELLI, M.
1953 – *Microfaune della serie elveziana del Rio Mazzapiedi-Castellania (Tortona-Alessandria).* Riv. Ital. Pal. Strat., Mem., no. 6, pp. 96–166.
1956 – *La serie aquitano-elveziana del Rio Mainia (Asti); Parte II — Descrizioni paleontologiche.* Riv. Ital. Pal. Strat., vol. 62, no. 2, pp. 63–108.

SALVATORI, U.
1956 – *I coralli ed i foraminiferi del Miocene inferiore di M. Curlo (Voghera).* Riv. Ital. Pal. Strat., vol. 62, no. 2, pp. 125–132.

VILLA, F. A.
1955 – *Studi stratigrafici sul Terziario subalpino lombardo; Nota IV — Gli affioramenti terziari a sud del lago di Varese.* Riv. Ital. Pal. Strat., vol. 61, no. 2, pp. 66–92.
1956 – *Studi stratigrafici sul Terziario subalpino lombardo; Nota VI — Microfaune e microfacies del Nummulitico di Travedona (Varese).* Riv. Ital. Pal. Strat., vol. 62, no. 2, p. 109–124.

ABSTRACT: *An ostracode fauna of eleven species is described from the Eocene Capay formation at Fig-Tree Gulch, Marysville Buttes, California. One species is considered to be conspecific with a Gulf Coast form, one is described as a* nomen apertum, *and nine are new. The genera* Cytherella, Bythocypris, Buntonia, Paijenborchella, Munseyella, Trachyleberis, Trachyleberidea, *and* Actinocythereis *are represented. The most noteworthy generic occurrence is that of* Paijenborchella, *hitherto unreported from the Western Hemisphere.*

Eocene ostracode fauna from Marysville Buttes, California

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INTRODUCTION

Marysville Buttes, remnants of an extinct volcanic structure of Tertiary age, rise from the flat Sacramento Valley in Sutter County, northern California (text-figure 1). According to Johnson (1943, pp. 611–614), the Buttes have been formed chiefly by intrusions of an andesitic plug and later rhyolite porphyries that pierce and fold Cretaceous and Tertiary strata. Erosion has exposed the upturned edges of these sediments around the periphery of the structure. Thus, marine deposits from near the center of the Sacramento Valley, covered elsewhere by nonmarine valley fill, are exposed to the hammer.

Eocene beds are well exposed in a small ravine, known locally as Fig-Tree Gulch, on the western side of the Buttes (inset A, text-figure 1). They contain abundant fossils, chiefly foraminifera, mollusks, and ostracodes, as well as the skeletal debris of other groups of organisms. The character of the foraminiferal and larger invertebrate assemblages has been established (see below). The purpose of this paper is to record the ostracode fauna, and thereby to begin the enumeration of California Eocene Ostracoda.

PREVIOUS WORK

Faunal description

Watts (1894) is said to have made the earliest reference to Marysville Buttes in the geologic literature; his report included a list of molluscan fossils from Fig-Tree Gulch. Cooper, who identified Watts' collection, described several species as new (1894). The Marysville Folio, containing the earliest geologic map of the Buttes, was published the following year (Lindgren and Turner, 1895); a coral and a mollusk were recorded from Fig-Tree Gulch. These early faunal records were reviewed by Dickerson (1913) in a monograph of the Eocene megafossils from Marysville Buttes. His large faunal list includes a single foraminifer (*Nodosaria* sp.), but no ostracodes. In a later paper, Dickerson (1916) described additional mollusks from Fig-Tree Gulch.

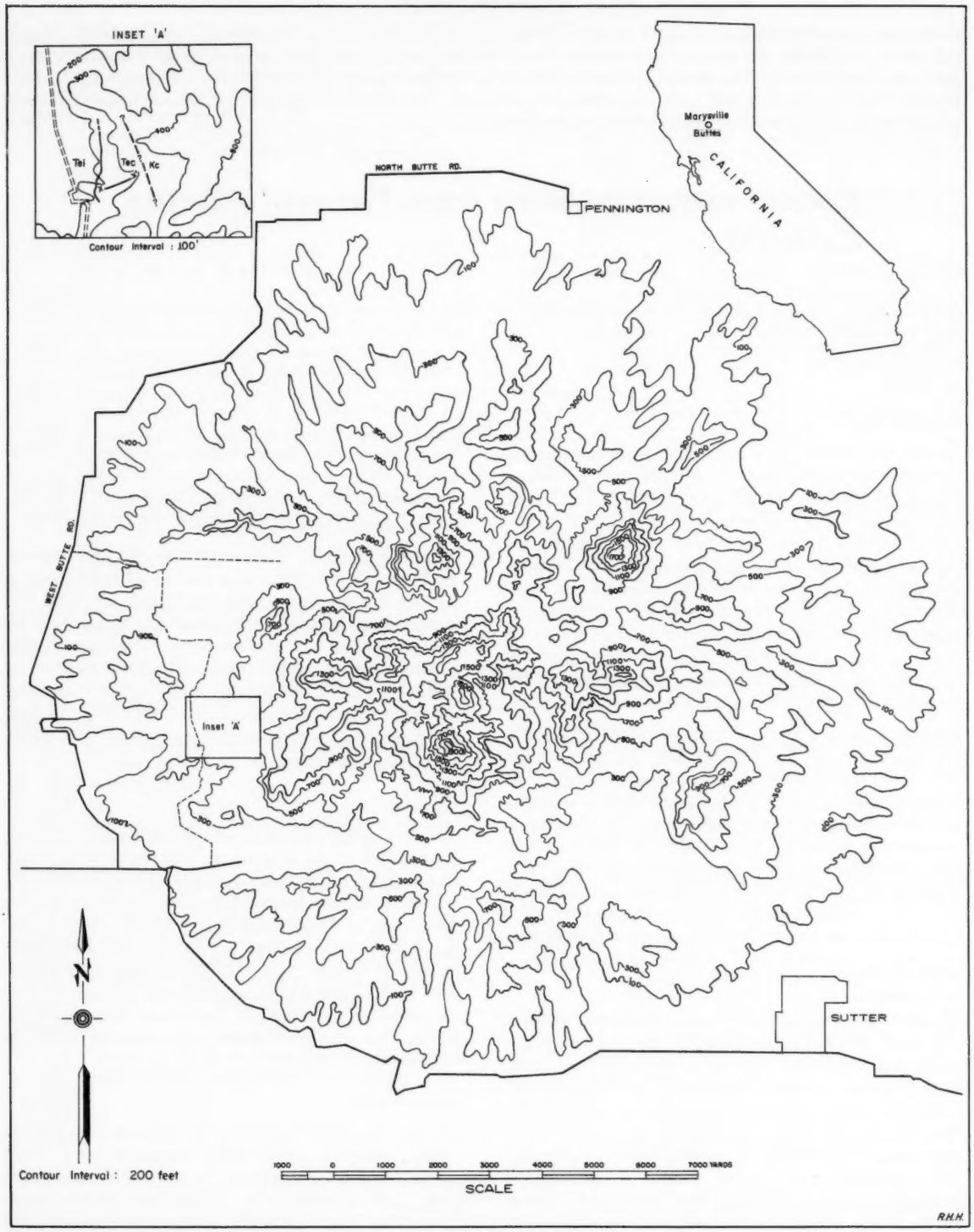
Microfossils from Dickerson's samples were studied by Stipp (MS., 1926) as a Master of Arts thesis at Stanford University, and his faunal list was subsequently published by Williams (1929); ostracodes are mentioned but not described. Two new megafossils were recorded from Fig-Tree Gulch by Merriam and Turner in 1937. More recently, Israelsky (1940) restudied foraminifera from Dickerson's samples, adding many new records and figuring forty-four forms.

Correlation

It is not necessary to trace here the entire history of correlation of the Eocene at Marysville Buttes. On the basis of subsurface data (Cross *et al.*, 1954), the marine Eocene is considered to be part of the Capay formation of Crook and Kirby (1935). The megafauna has been assigned to the Capay stage (Merriam and Turner, 1937). It was suggested by Goudkoff and Mendoza, in an unpublished but widely circulated range chart of California Eocene foraminifera, that the microfauna represents the B-4 zone of Laiming (1940).

PRESENT WORK

At Fig-Tree Gulch, the Capay formation is a gray-green, massive, glauconitic claystone (Tec, inset A, text-figure 1). It overlies Upper Cretaceous shales (Kc), and is overlain by nonmarine Eocene sands (Tei). The lower contact is covered by alluvium, and as the claystone is slumped and its attitude inde-



TEXT-FIGURE 1

MARYSVILLE BUTTES, SHOWING FIG-TREE GULCH AREA, SUTTER COUNTY, CALIFORNIA

terminate, its thickness in outcrop is not known. It may be on the order of 100 to 300 feet thick.

A composite sample was taken along line X–X′ (inset A, text-figure 1). Approximately twenty pounds of sample were washed and the ostracodes picked at the Humble Oil & Refining Company laboratory at Chico, California.

ACKNOWLEDGMENTS

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Special thanks are due Mrs. Joyce Rogers, of Chico, California, for preparation of the ostracode illustrations. The Humble Oil & Refining Company generously permitted the use of its facilities during the course of this study.

SYSTEMATIC DESCRIPTIONS

All figured types are deposited in the collections of the California Academy of Sciences, in San Francisco (abbreviated C.A.S. below). Paratypes of the more abundant new species are deposited at the University of California, Los Angeles, and in the H. V. Howe Collection at Louisiana State University, Baton Rouge, Louisiana. References to supraspecific taxonomic categories and to type species will be found in Howe's *Handbook of ostracod taxonomy* (1955).

Order OSTRACODA Latreille, 1802

Suborder PLATYCOPA Sars, 1866

Family CYTHERELLIDAE Sars, 1866

Genus CYTHERELLA Jones, 1849

(Type species: *Cytherina ovata* Roemer, 1840.)

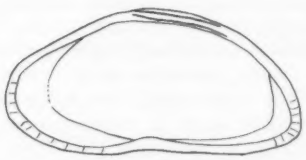
Cytherella sp.
Plate 1, figures 1, 2a–c

Carapace medium-sized, punctate, subquadrate, highest near the center and widest at the posterior quarter-line. Dorsal and ventral outlines gently convex; anterior outline broadly and obliquely rounded, with anterior extremity slightly dorsal to center line; posterior outline obliquely rounded, with posterior extremity about at ventral one-third line. Hinge structure consists of a shallow groove in right valve, into which a simple ridge of left valve fits.

Dimensions of hypotype, a complete carapace: Length 0.65 mm.; height 0.36 mm.; width 0.30 mm.

Remarks: Specimens of *Cytherella* from Fig-Tree Gulch do not possess characters that permit specific assignment. They are therefore described and figured as a *nomen apertum*. Common at Fig-Tree Gulch.

Types: Hypotypes, no. 10483 and no. 10484, C.A.S. collection.



TEXT-FIGURE 2

Bythocypris? gibsonensis Howe and Chambers, interior of right valve, × 55: hypotype, C.A.S. collection, no. 10491.

Suborder PODOCOPA Sars, 1866

Family BAIRDIIDAE Sars, 1887

Subfamily BAIRDIINAE Sars, 1923

Genus BYTHOCYPRIS Brady, 1880

(Type species: *Bairdia bosquetiana* Brady, 1866.)

Bythocypris? gibsonensis Howe and Chambers
Plate 1, figure 3a–c; text-figure 2

Bythocypris? gibsonensis HOWE AND CHAMBERS, 1935, Louisiana Dept. Cons,, Geol. Bull. no. 5, pp. 9–10, pl. 3, fig. 10; pl. 4, fig. 3. – HOWE AND LAW, 1936, Louisiana Dept. Cons., Geol. Bull. no. 7, p. 26, pl. 1, figs. 34–37.—SWAIN, 1946, Jour. Pal., vol. 20, p. 375, pl. 54, fig. 4a–e.

Carapace medium-sized, smooth, elongate, highest and widest just anterior to center. Dorsal margin broadly arched; anterior margin rounded; ventral outline in left valve nearly straight to gently convex, in right valve gently convex near extremities with a broad, concave indentation just anterior to center; posterior margin angulate ventrally, most sharply in right valve. Hinge simple.

Dimensions of hypotype, a complete carapace: Length 0.84 mm.; height 0.44 mm.; width 0.33 mm.

Remarks: This species was described from the Middle Eocene (Jackson) at Gibson Landing on the Ouachita River, Caldwell Parish, Louisiana. It is recorded from strata of Claiborne age in Florida (Swain, 1946) and ranges to the Oligocene (Vicksburg) (Howe and Law, 1936). Common at Fig-Tree Gulch.

Types: Hypotypes, no. 10490 and no. 10491, C.A.S. collection.

Family CYTHERIDAE Baird, 1850

Subfamily CYTHERINAE Dana, 1853

Genus BUNTONIA Howe, 1935

(Type species: *Buntonia shubutaensis* Howe, 1935.)

Buntonia delta Marianos and Valentine, **new species**

Plate 1, figures 6a–b, 7

Carapace medium-sized, pyriform; widest at posterior one-third line, highest at anterior cardinal angle. Dorsal margin nearly straight, slightly concave posteriorly; anterior margin broadly rounded above, more sharply rounded below; ventral margin gently convex, indented anterior to center; posterior margin narrow, narrowly rounded below and angled above; in left valve the posterior cardinal angle is somewhat produced. Surface ornamented by numerous low ridges, strongest on inflated posteroventral portion of valve, where they run in general longitudinally; dorsally and anteriorly they become nearly obsolete; interspaces between longitudinal ridges crossed by low, rather regularly spaced transverse ridges, which divide them into pits. Margin reflected posteroventrally to form a sinus, leaving a gape when valves are articulated; margin denticulate at sinus.

Hinge of right valve with rounded anterior tooth and subjacent socket, connected by a narrow groove to a longitudinally elongate posterior tooth. Hinge of left valve with anterior socket and rounded subjacent tooth, connected by narrow margin to longitudinally elongate posterior socket. Radial pore canals straight and numerous.

Dimensions of holotype, a complete carapace: Length 0.56 mm.; height 0.36 mm.; width 0.33 mm.

Remarks: This species resembles *Buntonia shubutaensis* Howe var. *morsei* (Howe and Pyeatt), as described by Howe and Chambers (1935), but it is more coarsely pitted and is narrower and more acutely angulate posteriorly. It is dimorphic; the relatively short and broad form is figured. Rare at Fig-Tree Gulch.

Types: Holotype, no. 10479; paratype, no. 10480; C.A.S. collection.

Buntonia seco Marianos and Valentine, **new species**

Plate 2, figure 7a–b

Carapace small, fragile, elongate in side view; widest at posterior quarter-line, highest at anterior cardinal angle. Dorsal margin straight or gently convex; anterior margin broadly rounded; ventral margin gently convex, indented just anterior to center; posterior margin angulated near center, convex both above and below angulation; dorsal and ventral margins converge posteriorly. Surface reticulate, with two low longitudinal ridges, one just above the center, the other ventral. Eye tubercle small. Margin raised, slightly reflected posteroventrally to form a narrow sinus.

Hinge of right valve with rounded anterior tooth and postjacent socket connected by a narrow groove to a small, oval posterior tooth. Hinge of left valve with anterior socket and rounded postjacent tooth, connected by a narrow margin to an oval posterior socket. Radial pore canals narrow, numerous, commonly bifurcating; most numerous anteriorly.

Dimensions of holotype, a single valve: Length 0.50 mm.; height 0.36 mm.; width 0.14 mm.

Remarks: *Buntonia seco* somewhat resembles *Buntonia alabamensis* (Howe and Pyeatt), as described by Howe and Garrett (1934), but it has more prominent longitudinal ridges and a wider but more acutely angulated posterior. It differs from *Buntonia subtriangularis* (Sutton and Williams) (1939) in having more subdued sculpture and a more evenly rounded anterior margin. Very rare at Fig-Tree Gulch.

Types: Holotype, no. 10477, C.A.S. collection.

TEXT-FIGURE 3

Munseyella israelskyi Marianos and Valentine, n. sp., interior of left valve, × 88; paratype, C.A.S. collection, no. 10486.

Genus MUNSEYELLA van den Bold, 1957

(Type species: *Toulminia hyalokystis* Munsey, 1953).

Toulminia Munsey, 1953, Jour. Pal., vol. 27, no. 1, p. 6 (not *Toulminia* Zittel 1878).

Munseyella israelskyi Marianos and Valentine, **new species**

Plate 2, figure 6a–b; text-figure 3

Carapace small, fragile, elongate in side view, compressed; widest near posterior quarter-line; highest at anterior cardinal angle. Dorsal margin straight or very slightly convex; anterior margin broadly and obliquely rounded; ventral margin nearly straight, indented just anterior to center, the indentation deepest in right valve; posterior margin blunt, rounded below and angulate dorsally. Posterior margin bears two small denticles. Surface covered by low, small, rounded nodes, except for the smooth marginal rims. Anterior marginal rim thick and moderately wide; the posterior marginal rim slightly thinner and narrower; a smooth ventral ridge that runs parallel with and slightly above the ventral margin joins anterior and posterior rims; another smooth ridge that is narrowly and somewhat obliquely convex posteriorly runs just in front of posterior margin. Eye tubercle small.

Hinge of right valve with small anterior tooth and postjacent socket that narrows posteriorly to a thin, nearly straight groove, terminating at a small posterior tooth that projects obliquely below posterior cardinal angle.

Hinge of left valve with small anterior socket and postjacent tooth that thins posteriorly into a nearly straight, narrow margin, terminating in an oblique socket below posterior cardinal angle; posterior socket open ventrally, and dorsal socket rim bears a small denticle at either end. Marginal pore canals straight, few.

Dimensions of holotype, a complete carapace: Length 0.35 mm.; height 0.20 mm.; width 0.15 mm.

Remarks: *Munseyella israelskyi* differs from *Munseyella hyalokystis* (Munsey) in having much simpler ornamentation and in its reduced anterior platform. Rare at Fig-Tree Gulch. Named in honor of Merle C. Israelsky, U.S. Geological Survey, Menlo Park, California.

Types: Holotype, no. 10485; paratype, no. 10486; C.A.S. collection.

Subfamily CYTHERURINAE Müller, 1894?

Genus PAIJENBORCHELLA Kingma, 1948

(Type species: *Paijenborchella iocosa* Kingma, 1948.)

Paijenborchella trigona Marianos and Valentine, **new species**

Plate 2, figures 3a–b, 4, 5a–b

Carapace small, thick, trigonal, markedly inflated, highest at anterior cardinal angle, widest slightly posterior to center. Dorsal margin of left valve broadly rounded, that of right valve straight and slightly inclined, dipping posteriorly; anterior margin broadly rounded; ventral margin strongly convex, indented anterior to center; posterior triangular, with caudal process along center line. Surface ornamented by deep median sulcus, longitudinal ridges, and pits; sulcus extends ventrally from anterior cardinal angle, terminating against a prominent ventral longitudinal ridge; between this ridge and ventral margin are two shorter, weaker ridges; a prominent ridge bridges the sulcus near center line; less prominent ridges extend both anteriorly and posteriorly from small eye tubercle parallel with dorsal margin; remainder of surface coarsely and evenly pitted. Cardinal tubercle prominent. Radial pore canals few, straight, absent from posterodorsal margin.

Hinge of right valve with small, crenulate anterior tooth and postjacent socket connected by shallow crenulate groove to crenulate posterior tooth. Hinge of left valve with anterior socket and postjacent crenulate tooth connected by narrow crenulate ridge to posterior socket. A broad accommodation groove ("Ausweichfurche" of Kingma) lies between left hingement and dorsal margin.

Dimensions of holotype, a complete carapace: Length 0.57 mm.; height 0.29 mm.; width 0.31 mm.

Remarks: *Paijenborchella*, which is reported from the late Cretaceous (Triebel, 1949) to the Recent (Ruggieri, 1953), has not previously been recorded from North America. *Paijenborchella trigona* is similar in shape to *Paijenborchella eocenica* (Triebel, 1949), but is thinner-shelled, has a shorter caudal process, and has a less prominent median ridge that lacks the hook-like projection. It is markedly dimorphic; the short form is figured. Very abundant at Fig-Tree Gulch.

Types: Holotype, no. 10492; paratypes, no. 10493 and no. 10494; C.A.S. collection.

Family TRACHYLEBERIDAE Sylvester-Bradley, 1948

Subfamily TRACHYLEBERINAE Sylvester-Bradley, 1948

Genus TRACHYLEBERIS Brady, 1898

(Type species: *Cythere scabrocuneata* Brady, 1880.)

Trachyleberis semihispida Marianos and Valentine, **new species**

Plate 1, figures 4a–b, 5

Carapace medium-sized, thick, robust, elongate in side view; highest anteriorly, widest at posterior quarter-line. Dorsal margin straight; anterior margin broadly and obliquely rounded, tangent to dorsal margin and continuing to ventral indentation just anterior to center; posterior margin angulated just dorsal to center line, nearly straight above and gently convex below, becoming nearly straight ventrally and continuing to indentation; posterior angulation most sharp in right valve, commonly nearly obsolete in left valve; dorsal and ventral margins converge posteriorly. Anterior and posterior margins bear denticulations that are most prominent ventrally. Surface coarsely reticulate, pits moderately deep, rounded to polygonal, surrounded by ridges of nearly equal height that commonly bear bluntly rounded to nearly pointed nodes at their intersections. Eye tubercle prominent, nearly or entirely surrounded by a collar of blunt nodes.

Hinge of right valve with blunt anterior tooth, rounded anteriorly and truncate posteriorly, and rounded subjacent socket, connected by a narrow, smooth, nearly straight dorsal furrow to a large, roundly pyramidal posterior tooth. Hinge of left valve with posteriorly truncate anterior socket connected by a smooth, narrowly rounded margin to a deep, pyramidal posterior socket. Radial pore canals numerous, straight.

Dimensions of holotype, a left valve: Length 1.04 mm.; height 0.49 mm.; width 0.26 mm.

Remarks: This species lacks the dorsal ridge and spiny, thickened posteroventral margin of *Trachyleberis orelliana* (Stadnichenko), which is well figured by Stephenson (1946). *Trachyleberis semihispida* is markedly dimorphic. The long form bears more prominent antero- and posteroventral denticulations, and has a large posteroventral tubercle on the left valve. Individuals of either form may appear quite hispid if many large nodes are developed at the intersections of the reticulate ridges. The relatively short, broad form is figured. Very abundant at Fig-Tree Gulch.

Types: Holotype, no. 10496; paratype, no 10497; C.A.S. collection.

Trachyleberis sutterensis Marianos and Valentine, **new species**
Plate 1, figure 8a–b

Carapace medium-sized, elongate in side view; highest anteriorly, widest at anterior quarter-line. Dorsal margin straight, anterior margin broadly and obliquely rounded, tangent to dorsal margin and continuing anteroventrally to ventral indentation just anterior to center; posterior margin angulated just dorsal to center line, concave above and convex below, becoming nearly straight ventrally and continuing to the indentation; dorsal and ventral margins converge posteriorly. Anterior and posterior margins with denticulations that are most prominent ventrally. Surface ornamented by spinose nodes connected by low, reticulating ridges, except in compressed areas near anterior and posterior margins, where the only sculpture consists of a few low ridges that are nearly normal to the margin, and of nearly obsolete ridges that run parallel with the margin. A low subcentral tubercle is commonly ornamented by a cluster of three or four short spines. Eye tubercle prominent.

Hinge of right valve with posteriorly truncate anterior tooth and subjacent socket, connected by narrow, straight dorsal furrow to large, longitudinally elongate posterior tooth. Hinge of left valve with anterior socket and subjacent tooth, connected by narrow, straight margin to longitudinally elongate posterior socket. Right anterior margin bears a raised internal rim that fits into corresponding depression in left valve. Radial pore canals straight, numerous, commonly paired.

Dimensions of holotype, a complete carapace: Length 0.71 mm.; height 0.40 mm.; width 0.73 mm.

Remarks: This species is dimorphic; the relatively short and broad form is figured. Common at Fig-Tree Gulch.

Types: Holotype, no. 10495, C.A.S. collection.

Trachyleberis paucispinata Marianos and Valentine, **new species**
Plate 2, figure 9a–b

Carapace medium-sized, thick, robust, elongate in side view, highest at anterior cardinal angle, widest at posterior quarter-line. Dorsal margin straight; anterior margin broadly and obliquely rounded, tangent to dorsal margin and continuing anteroventrally to nearly obsolete ventral indentation slightly anterior to center; posterior margin angulated just above center, straight or slightly concave above and convex below, becoming nearly or quite straight ventrally and continuing to ventral indentation; dorsal and ventral margins converge posteriorly. Anterior margin with double row, posterior margin with single row of denticulations that are most prominent ventrally. Surface unevenly reticulate, most coarsely near anterior margin, where reticulating ridges are least prominent. Ornamented also by several bluntly pyramidal, rather widely spaced, grooved nodes, the largest of which are aligned near longitudinal center line, but dip slightly anteroventrally; a few weaker nodes are aligned parallel to these near the ventral margin; other nodes lie near the dorsal margin. Eye tubercle prominent.

Hinge of right valve with small, rounded anterior tooth and subjacent socket connected by straight, narrow groove to large, oblique posterior tooth that projects laterally and dorsally above margin. Hinge of left valve with small anterior socket and small, rounded subjacent tooth connected by straight, narrow margin to large, oblique posterior socket, the rim of which forms a slight marginal projection at the posterior cardinal angle. Radial pore canals straight, numerous.

Dimensions of holotype, a complete carapace: Length 0.86 mm.; height 0.43 mm.; width 0.35 mm.

Remarks: Rare at Fig-Tree Gulch.

Types: Holotype, no. 10478, C.A.S. collection.

PLATE 1

1 *Cytherella* sp.
Interior of right valve, × 63; hypotype, C.A.S. collection, no. 10483.

2 *Cytherella* sp.
Paired valves, × 63: a, left side; b, ventral margin; c, dorsal margin; hypotype, C.A.S. collection, no. 10484.

3 *Bythocypris? gibsonensis* Howe and Chambers
Paired valves, × 55: a, right side; b, dorsal margin; c, ventral margin; hypotype, C.A.S collection, no. 10490.

4 *Trachyleberis semihispida* Marianos and Valentine, n. sp.
Left valve, × 55: a, exterior; b, interior; holotype, C.A.S. collection, no. 10496.

5 *Trachyleberis semihispida* Marianos and Valentine, n. sp.
Interior of right valve, × 55; paratype, C.A.S. collection, no. 10497.

6 *Buntonia delta* Marianos and Valentine, n. sp.
Paired valves, × 57: a, right side; b, ventral margin; holotype, C.A.S. collection, no. 10479.

7 *Buntonia delta* Marianos and Valentine, n. sp.
Interior of left valve, × 57; paratype, C.A.S. collection, no. 10480.

8 *Trachyleberis sutterensis* Marianos and Valentine, n. sp.
Paired valves, × 60: a, right side; b, dorsal margin; holotype, C.A.S. collection, no. 10495.

1

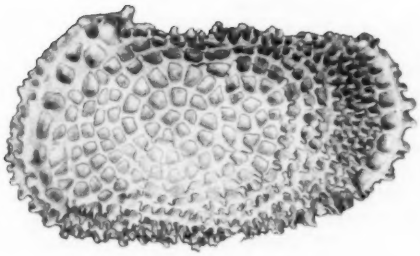
2a

3a

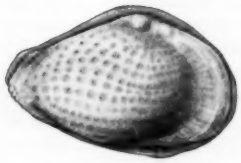
2b

2c

3b

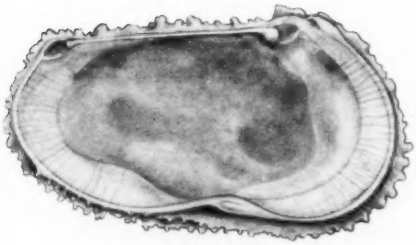


4a



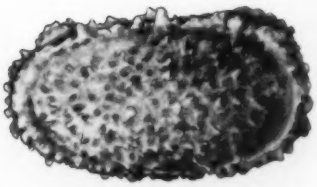
6a

3c

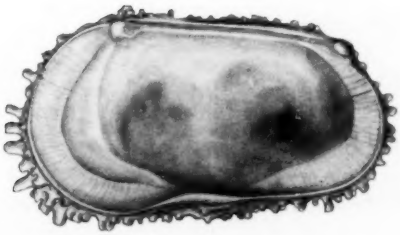


4b

6b



8a



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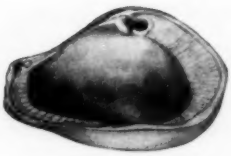
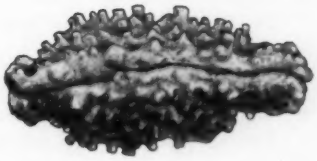


7



8b

TEXT-FIGURE 4

Trachyleberidea capayensis Marianos and Valentine, n. sp., × 57: a, right valve, paratype, C.A.S. collection, no. 10488; b, left valve, paratype, C.A.S. collection, no. 10489.

Genus TRACHYLEBERIDEA Bowen, 1953

(Type species: *Cythereis prestwichiana* Jones and Sherborn, 1887.)

Trachyleberidea capayensis Marianos and Valentine, **new species**

Plate 2, figure 8a–b; text-figure 4

Carapace medium-sized, elongate-pyriform in side view, compressed; periphery truncate; widest at posterior one-third line, highest at anterior cardinal angle. Dorsal margin straight; anterior margin broadly rounded; ventral margin gently convex, but slightly indented near center; posterior margin angulated below center, convex below, straight or slightly concave above; posterodorsal margin subrounded; dorsal and ventral margins converge posteriorly. Surface coarsely reticulate and also ornamented by three prominent longitudinal ridges. Marginal areas thickened, raised, most distinctly along anterior and posterior margins; anterior margin denticulate, posterior margin denticulate below angulation. Eye tubercle small. Radial pore canals numerous, straight.

Hinge of right valve with smooth, wedge-shaped anterior tooth and subjacent socket connected by straight, narrow groove to long, smooth, oblique, dorsally projecting posterior tooth. Hinge of left valve with anterior socket and subjacent tooth connected by straight, narrow margin to oblique posterior socket, the rim of which forms a marginal projection at posterior cardinal angle.

Dimensions of holotype, a complete carapace: Length 0.58 mm.; height 0.37 mm.; width 0.23 mm.

Remarks: Rare at Fig-Tree Gulch.

Types: Holotype, no. 10487; paratypes, no. 10488 and no. 10489; C.A.S. collection.

Genus ACTINOCYTHEREIS Puri, 1953

(Type species: *Cythere exanthemata* Ulrich and Bassler, 1904.)

Actinocythereis howei Marianos and Valentine, **new species**

Plate 2, figures 1a–b, 2

Carapace medium-sized, elongate, thick; highest anteriorly, widest just posterior to center. Dorsal margin straight; anterior margin rounded, tangent to dorsal margin and continuing anteroventrally to ventral indentation just anterior to center; posterior margin angulated just dorsal to center, concave or straight above and gently convex below angulation; dorsal and ventral margins converge posteriorly. Double rows of subdued denticulations lie along anterior and posterior margins, most prominent on right valve. Surface or-

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PLATE 2

1 *Actinocythereis howei* Marianos and Valentine, n. sp.
Left valve: a, exterior, × 53; b, interior, × 56; holotype, C.A.S. collection, no. 10481.

2 *Actinocythereis howei* Marianos and Valentine, n. sp.
Interior of right valve, × 50; paratype, C.A.S. collection, no. 10482.

3 *Paijenborchella trigona* Marianos and Valentine, n. sp.
Right valve, × 52: a, exterior; b, interior; paratype, C.A.S. collection, no. 10494.

4 *Paijenborchella trigona* Marianos and Valentine, n. sp.
Dorsal margin of left valve, × 52; paratype, C.A.S. collection, no. 10493.

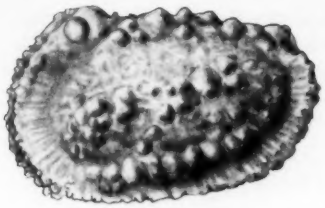
5 *Paijenborchella trigona* Marianos and Valentine, n. sp.
Paired valves, × 52: a, ventral margin; b, dorsal margin; holotype, C.A.S. collection, no. 10492.

6 *Munseyella israelskyi* Marianos and Valentine, n. sp.
Paired valves, × 60: a, right side; b, dorsal margin; holotype, C.A.S. collection, no. 10485.

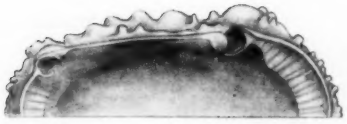
7 *Buntonia seco* Marianos and Valentine, n. sp.
Right valve, × 50: a, exterior; b, interior; holotype, C.A.S. collection, no. 10477.

8 *Trachyleberidea capayensis* Marianos and Valentine, n. sp.
Paired valves, × 60: a, left side; b, dorsal margin; holotype, C.A.S. collection, no. 10487.

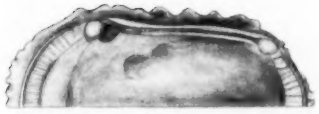
9 *Trachyleberis paucispinata* Marianos and Valentine, n. sp.
Paired valves, × 53: a, right side; b, dorsal margin; holotype, C.A.S. collection, no. 10478.



1a

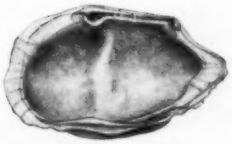


1b



2

3a

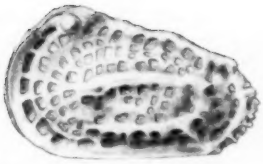


3b

4

5a

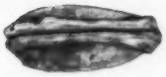
5b



8a

8b

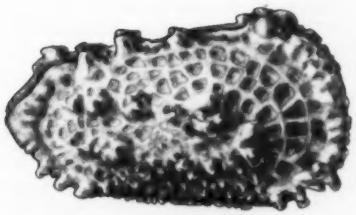
6a



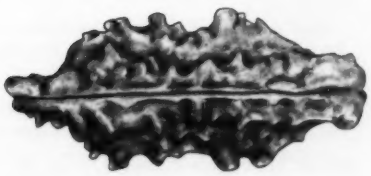
6b

7a

7b



9a



9b

namented by three rows of close-set, longitudinally aligned nodes, one along dorsal margin, a second median and somewhat oblique, dipping anteroventrally, a third just above ventral margin and nearly or quite parallel to median row. All three rows stop at about the anterior and posterior one-sixth lines. Ventral row shorter than the other two; median row interrupted near center of valve. Small, scattered, rounded to pointed secondary nodes occur between rows of nodes, and occasionally behind or in front of them, and are most numerous on left valve. Anterodorsal cardinal tubercle prominent.

Hinge of right valve with bluntly pyramidal anterior tooth and subjacent socket, connected by narrow groove to large, smooth, nearly flat-topped, somewhat elongate posterior tooth. Hinge of left valve with deep anterior socket and subjacent tooth, connected by straight, narrowly rounded margin to large, obliquely elongate posterior socket. Radial pore canals numerous, straight, thick.

Dimensions of holotype, a left valve: Length 0.81 mm.; height 0.46 mm.; width 0.25 mm.

Remarks: Common at Fig-Tree Gulch. Named in honor of Professor H. V. Howe, Louisiana State University, Baton Rouge, Louisiana.

Types: Holotype, no. 10481; paratype, no. 10482; C.A.S. collection.

BIBLIOGRAPHY

Cooper, J. G.
1894 – *Catalogue of California fossils.* California, State Mining Bur., Bull., no. 4, pp. 36–45.

Crook, T. H., and Kirby, J. M.
1935 – *Capay formation.* (Abstract.) Geol. Soc. Amer., Proc. (1934), pp. 334–335.

Cross, C. W., and others
1954 – *Correlation chart, northern Sacramento Valley.* Distributed by Amer. Assoc. Petrol. Geol., Pacific Section.

Dickerson, R. E.
1913 – *Fauna of the Eocene at Marysville Buttes, California.* California, Univ., Publ., Bull. Dept. Geol., vol. 7, pp. 257–298, pls. 11–14.

1916 – *Stratigraphy and fauna of the Tejon Eocene of California.* California, Univ., Publ., Bull. Dept. Geol., vol. 9, pp. 363–524, pls. 36–42.

Howe, H. V.
1955 – *Handbook of ostracod taxonomy.* Louisiana, State University, Studies, Phys. Sci. Ser., no. 1, pp. 1–389.

Howe, H. V., and Chambers, J.
1935 – *Louisiana Jackson Eocene Ostracoda.* Louisiana, Dept. Cons., Geol. Bull., no. 5, pp. 1–65, pls. 1–6.

Howe, H. V., and Garrett, J. B., Jr.
1934 – *Louisiana Sabine Eocene Ostracoda.* Louisiana, Dept. Cons., Geol. Bull., no. 4, pp. 1–64, pls. 1–4.

Howe, H. V., and Law, J.
1936 – *Louisiana Vicksburg Oligocene Ostracoda.* Louisiana, Dept. Cons., Geol. Bull., no. 7, pp. 1–96, pls. 1–6.

Israelsky, M. C.
1940 – *Notes on some foraminifera from Marysville Buttes, California.* Pacific Sci. Congress, 6th, Proc., vol. 2, pp. 569–595, pls. 1–7.

Johnson, H. R.
1943 – *Marysville Buttes (Sutter Buttes) gas field.* California, Div. Mines, Bull., no. 118, pp. 610–615.

Kingma, J. T.
1948 – *Contributions to the knowledge of the Young-Caenozoic Ostracoda from the Malayan region.* (Utrecht, Univ., doct. diss.) Utrecht: Kemink en Zoon, 118 pp., pls. 1–12.

Laiming, B.
1940 – *Some foraminiferal correlations in the Eocene of San Joaquin Valley, California.* Pacific Sci. Congress, 6th, Proc., vol. 2, pp. 535–568.

Lindgren, W., and Turner, H. W.
1895 – *Marysville folio.* U. S. Geol. Survey, Folio no. 17.

Merriam, C. W., and Turner, F. E.
1937 – *The Capay Middle Eocene of northern California.* California, Univ., Publ., Bull. Dept. Geol. Sci., vol. 24, pp. 91–114, pls. 5–6.

Ruggieri, G.
1950 – *Una nuova Paijenborchella del Pliocene della Calabria.* Giorn. Geol., ser. 2, vol. 21, pp. 59–63, 2 text-figs.

1953 – *Ostracodi del genere Paijenborchella viventi nel Mediterraneo.* Soc. Ital. Sci. Nat., Atti, vol. 92, no. 1, pp. 11–14, text-figs. 1–5.

Stadnichenko, M. M.
1927 – *The foraminifera and Ostracoda of the marine Yegua of the type sections.* Jour. Pal., vol. 1, pp. 221–244, pls. 38–39.

Stephenson, M. B.
1946 – *Weches Eocene Ostracoda from Smithville, Texas.* Jour. Pal., vol. 20, no. 4, pp. 297–344, pls. 42–45.

Stipp, T. F.
[MS.] *The Eocene foraminifera of the Marysville Buttes.* Stanford Univ., Master of Arts thesis (1926, unpublished).

Sutton, A. H., and Williams, J. R.
1939 – *Ostracoda from the Weches formation at Smithville, Texas.* Jour. Pal., vol. 13, pp. 561–574, pls. 63–64.

Swain, F. M.
1946 – *Ostracoda from the Tertiary of Florida.* Jour. Pal., vol. 20, no. 4, pp. 374–383, pls. 54–55.

Triebel, E.
1949 – *Zur Kenntnis der Ostracoden-Gattung Paijenborchella.* Senckenbergiana, vol. 30, pp. 193–203, pls. 1–3.

Watts, W. C.
1894 – *The gas and petroleum yielding formation of the Central Valley of California.* California, State Mining Bur., Bull., no. 3, pp. 9–10.

Williams, H.
1929 – *Geology of the Marysville Buttes, California.* California, Univ., Publ., Bull. Dept. Geol. Sci., vol. 18, pp. 103–220, pls. 9–19.

ABSTRACT: *The principles of classification of the Miogypsinidae are discussed. Two new species,* Miogypsina (Miogypsina) bhogatensis *Mohan and* Miogypsina (Lepidosemicyclina) droogeri *Mohan and Tiwari, are described, and the subgenus* Lepidosemicyclina *Rutten, 1911, is reinstated.*

Miogypsinidae from western India

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INTRODUCTION

Because of their importance in the recognition of the Miocene stages, the Miogypsinidae have received considerable attention in recent years. Important contributions have been made by Rutten (1911, 1912, 1926), Cushman (1918, 1948), Vaughan (1924*a*, *b*, 1926, 1928), Yabe and Hanzawa (1928, 1929, 1930), Hanzawa (1931, 1935, 1938, 1940, 1947), Tan Sin Hok (1932, 1936, 1937*a*, *b*), Barker (1932), Barker and Grimsdale (1937), Cole (1938, 1941, 1945), Vaughan and Cole (1941, 1948), van der Vlerk (1924), David-Sylvain (1937), Bronnimann (1940), Gravell (1933), Thalmann (1932, 1947), Tobler (1926, 1927), and Drooger (1951*a*, *b*, 1952, 1953, 1954*a*, *b*).

The rotalioid ancestry of the family has been accepted by the majority of workers. The discovery of stolon passages has necessitated the removal of the Miogypsinidae from the Orbitoididae, and the absence of a marginal cord dissociates them from the Nummulitidae. They are now recognised as an independent family.

The present paper deals with the general and systematic account of the family Miogypsinidae in western India. In collaboration with A. K. Chatterji, the present author (1956) has already published a detailed account of the stratigraphy of the Miocene beds of Kathiawar on the basis of the foraminiferal fauna. The correlation of the Miocene beds of western India with equivalent beds in Ceylon, Indonesia, and the Middle East has been published recently by Rao *et al.* (1957).

ACKNOWLEDGMENTS

The author takes this opportunity to express his gratitude to Professor S. R. N. Rao for his invaluable guidance. The author is also indebted to Drs. C. W. Drooger and S. Hanzawa for their critical comments and suggestions. This paper is abridged from a thesis submitted in 1954 for the degree of Doctor of Philosophy in the Faculty of Science of the University of Lucknow. The author is presently engaged in postdoctoral research at the State Museum and Department of Geology, University of Nebraska, Lincoln. The description of the new species *Miogypsina (Lepidocyclina) droogeri*, from the Kutch region, was written in collaboration with Mr. B. S. Tewari.

HISTORICAL REVIEW AND DISCUSSION

Vaughan (1928) included *Miogypsina* and *Miolepidocyclina* in the subfamily Miogypsininae Vaughan, under the Orbitoididae. Tan (1936) and Barker and Grimsdale (1937) demonstrated the presence of a canal system, and they further pointed out the rotalioid development of the early chambers. David-Sylvain (1937) suggested the derivation of *Miogypsina* from the Calcarinidae.

Yabe and Hanzawa (1928) established a new subgenus *Miogypsinoides* for *Miogypsina dehaarti* van der Vlerk. This species is characterised by thick lateral walls with lamellar structure, instead of by distinct tiers of lateral chambers.

Tan (1932), in his studies on the genus *Cycloclypeus*, introduced for the first time the concept of "bioseries" in micropaleontology. Since a classification cannot be based on a single bioseries, he took into consideration the correlation of characters in several bioseries. The principle of phylogenetic stages as determined from the fossil record was extended by him to *Lepidocyclina* and *Miogypsina*. He introduced a method of statistical analysis and an elaborate terminology for describing the different types of juvenarium. He regarded the study of the juvenarium as having the highest importance in the taxonomy of orbitoids and miogypsines. Tan's principles and methods have in general been accepted by other

workers, although the different types of juvenarium which he recognised are considered to be artificial and overlapping, as well as somewhat difficult to apply in practice (Hanzawa, 1940; Drooger, 1952).

Tan published his classification of the Miogypsinidae in 1936. He raised the subfamily Miogypsininae Vaughan, 1928, to the rank of a family. The two subgenera *Miogypsina* Sacco *sensu stricto* and *Miolepidocyclina* Silvestri were placed under the genus *Miogypsina* Sacco *sensu lato*, whereas the subgenera *Miogypsinoides* Yabe and Hanzawa and *Conomiogypsinoides* Tan were placed under the genus *Miogypsinoides* Yabe and Hanzawa. *Conomiogypsinoides* Tan has since been reduced to a synonym of *Miogypsinoides* Yabe and Hanzawa.

Bronnimann (1940), in his memoir on the Tertiary orbitoids of northwestern Morocco, presented a classification of the Miogypsinidae which closely followed that of Tan (1936). The *borneensis* type of juvenarium was not found in specimens from Morocco. Bronnimann concluded that the *indonesiensis* type of juvenarium (which Tan thought was restricted to Indonesia) was the most highly evolved type in the family. This is in accordance with the later views of Tan (1937*b*).

Hanzawa (1940) included the subfamily Miogypsininae Vaughan, 1928, in the family Rotaliidae, and established two new subgenera, *Miogypsinella* and *Miogypsinopsis*. Vaughan and Cole (1941) were of the opinion that *Miogypsinopsis* should be referred to *Miogypsina*, and *Miogypsinella* to *Miogypsinoides*.

Hanzawa (1947) recognised the family Miogypsinidae Tan, and revised the classification as follows:

Family Miogypsinidae Tan, 1936

Subfamily Miogypsininae Vaughan, 1928

Embryonic apparatus marginal..... .....*Miogypsina* Sacco, 1893
Embryonic apparatus subcentral..... .....*Miolepidocyclina* Silvestri, 1907

Subfamily Miogypsinoidinae Hanzawa, 1947

Proloculum marginal, without lateral chambers... .....*Miogypsinoides* Yabe and Hanzawa, 1928
Proloculum marginal, with rudimentary lateral chambers ..... *Miogypsinella* Hanzawa, 1940
Proloculum marginal, with lateral chambers ....*Miogypsinopsis* Hanzawa, 1940
Proloculum subcentral, with lateral chambers ....*Heterosteginoides* Cushman, 1918

Vaughan and Cole (1948), in their latest classification, recognised two genera, *Miogypsina* Sacco *sensu lato* and *Miogypsinoides* Yabe and Hanzawa, and one subgenus, *Miolepidocyclina* Silvestri, under the genus *Miogypsina*, in the family Miogypsinidae Tan. They considered *Heterosteginoides* Cushman a synonym of *Miolepidocyclina*, and *Conomiogypsinoides* Tan and *Miogypsinella* Hanzawa identical with *Miogypsinoides*.

The latest contributions are those of Drooger (1951*a*, *b*, 1952, 1953, and 1954*a*, *b*), who has investigated American, Indonesian, Italian, and Moroccan representatives of the family. Drooger employs statistical methods in evaluating the taxonomic criteria used by Tan and Bronnimann. According to Drooger, no two closely allied species usually exist side by side in modern marine faunas, and a sample contains only one species of any genus if no morphological discontinuities can be proved. He thinks that the application of Tan's five types of juvenarium would result in splitting a homogeneous population into artificial species.

Drooger accepts Tan's principle of nepionic change as the basis of his classification. He states (1952, p. 1): "On arranging the investigated samples according to the morphological characters of their nepionic stages a more or less continuous succession is obtained for most of the occurrences." In addition to nepionic acceleration, other characters which he considers important in defining subgeneric boundaries are the presence or absence of lateral chambers and the position of the early ontogenetic stages in the median layer with respect to the periphery. It is well known that the evolutionary rate of a bioseries may be accelerated or retarded, and Drooger's study of American species reveals that nepionic acceleration may be stationary or reversed.

In 1952, Drooger introduced quantitative methods for expressing some of the phylogenetic changes so that the data can be used for statistical analysis. The degree of the change from nepionic asymmetry to bilateral symmetry (Bronnimann, 1940; Hanzawa, 1947) is measured by the value of $200\alpha/\beta$, which is expressed numerically as the relative length of the two protoconchal spires in specimens with two auxiliary chambers. This figure is of some value in delimiting species. Another measurement introduced by Drooger is the angle γ. This angle in the median section is formed by the apical-frontal line through the centre of the protoconch and the line connecting the centre of the embryonic apparatus, taken at the side of the deuteroconch.

In his classification Drooger recognised one genus, *Miogypsina*, with the following five subgenera: *Miogypsina* Sacco, *Miogypsinella* Hanzawa, *Miogypsinoides* Yabe and Hanzawa, *Miolepidocyclina* Silvestri, and *Miogypsinita* Drooger. In his phylogenetic scheme he regarded *Miogypsinita*, *Miolepidocyclina*, and *Miogypsinella* as side branches.

In 1953 Drooger reinvestigated *Miogypsinoides dehaarti* (van der Vlerk). In the lateral walls of the same individuals, he found both lamellar structure and distinct lateral chambers. He concluded that the subdivision of *Miogypsina* into *Miogypsinoides* and *Miogypsinella* (without lateral chambers) is not valid, and that only *Miogypsinoides* should be retained for all species without lateral chambers.

On the basis of a study of Indian Miogypsinidae, the author considers the following data to be of some significance in delimiting species:

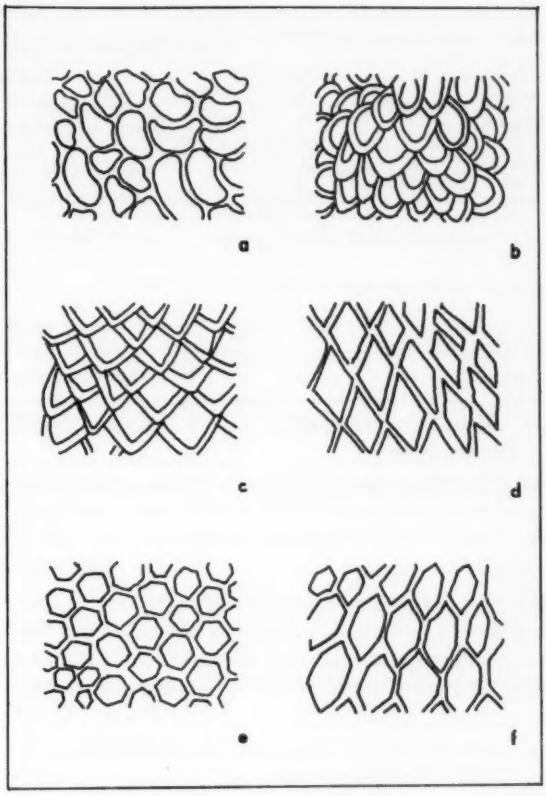
1) The numerical value of $200\alpha/\beta$ is of significance in specific determination.
2) The angle γ shows a well defined trend, and is of value in determining species.
3) In the evolution of equatorial chambers, the order suggested by Tan (1936) is also recognised. Although the stages have received little recognition in taxonomic work, in western India they were found to be of diagnostic value (see text-fig. 1).
4) There is no definite relationship between the size of the juvenarium and the size of the test.
5) The size of the granulations depends upon the age of the individual; they are a gerontic feature.
6) The Indian Miogypsinidae represent a good example of nepionic acceleration; the sequence is as follows:

a) In the subgenus *Miogypsina* Sacco *sensu stricto*:

M. (*M.*) *bhogatensis* Mohan, n. sp.	"*Orbiculina*" limestones; locality H.
M. (*M.*) *irregularis*	Visawara limestones; locality Vf.
M. (*M*) *irregularis*, variant *B*; *M.* (*M.*) *irregularis*, variant *A*	Bhatia limestones; localities B, D, and F.

b) In the subgenus *Lepidosemicyclina* Rutten:

M. (*L.*) *droogeri* Mohan and Tewari, n. sp.	"*Orbiculina*" shales; locality Vinjhan-Miani.
M. (*L.*) *polymorpha*	"*Orbiculina*" limestones; locality H.
M. (*L.*) *thecideaeformis*	Visawara limestones; locality Vf.



TEXT-FIGURE 1

a–b, predominance of arcuate to ogival equatorial chambers in *Miogypsina* (*Miogypsina*) *irregularis* (Michelotti), variant *A*; b–c, predominance of ogival to isodiametric-rhombic equatorial chambers in *Miogypsina* (*Miogypsina*) *irregularis* (Michelotti), variant *B*; d, predominance of elongate-rhombic equatorial chambers in *Miogypsina* (*Miogypsina*) *bhogatensis* Mohan, n. sp.; e, predominance of isodiametric-hexagonal equatorial chambers in *Miogypsina* (*Lepidosemicyclina*) *thecideaeformis* (Rutten); f, predominance of elongate-hexagonal chambers in *Miogypsina* (*Lepidosemicyclina*) *polymorpha* (Rutten) and *Miogypsina* (*Lepidosemicyclina*) *droogeri* Mohan and Tewari, n. sp. All figures × ca. 60.6.

In the present work the two subfamilies Miogypsininae Vaughan, 1928, and Miogypsinoidinae Hanzawa, 1947, are recognised. All the species described herein belong to the subfamily Miogypsininae. On the basis of the hexagonal chambers, the subgenus *Lepidosemicyclina* Rutten, 1911, is reinstated as a subgenus of *Miogypsina* Sacco, *sensu lato* (see also Mohan, in Mohan and Chatterji, 1956).

TABLE 1

LOCALITY Vf

Species	Shape of equatorial chambers	$L\gamma$	$200\alpha/\beta$
M. (*Miogypsina*) *irregularis*	non-elongate to slightly elongate-rhombic	0° to 40° Mγ = 23°	0 to 45 M$200\alpha/\beta$ = 20
M. (*Lepidosemicyclina*) *thecideaeformis*	mostly isodiametric-hexagonal	20° to 40° Mγ = 38°	25 to 50 M$200\alpha/\beta$ = 37

LOCALITY H

Species	Shape of equatorial chambers	$L\gamma$
M. (*Miogypsina*) *bhogatensis* Mohan, n. sp.	elongate-rhombic	0° to 30° Mγ = 8°
M. (*Lepidosemicyclina*) *polymorpha*	elongate-hexagonal	30° to 65° Mγ = 44°

LOCALITY VINJHAN-MIANI

Species	Shape of equatorial chambers	Notation or x	$200\alpha/\beta$	D_{ii}/D_i
M. (*Miogypsina*) *irregularis*	ogival to rhombic	6	0	1.0 to 1.2
M. (*Lepidosemicyclina*) *droogeri* Mohan and Tewari, n. sp.	elongate-hexagonal	$2\frac{1}{2}$–$2\frac{1}{2}$ $3\frac{1}{2}$–$2\frac{1}{2}$	73–100	1.2 to 1.5

In the samples from localities H (Bhogat), Vf (Visawara), and Vinjhan-Miani (Kutch), it was found that there are two morphologically different groups: one in which hexagonal chambers predominate, and the other with fewer hexagonal chambers. Since these two groups occur together and do not exhibit any morphological gradation, they are regarded as different species. The chief morphological differences between the two groups are shown in Table 1.

It is evident from the data given in Table 1 that the population present at each of these three localities consists of two groups: one in which hexagonal equatorial chambers predominate, and the other with few or no hexagonal chambers. Other morphological considerations indicate that the two groups are distinct species. It is therefore concluded that hexagonal chambers have a taxonomic value. On this basis it is proposed that Rutten's subgenus *Lepidosemicyclina* be reinstated to accommodate all the species in which hexagonal chambers predominate. An attempt has been made to represent graphically the tendency for hexagonal chambers to appear very early in the ontogenetic development of individuals of this subgenus (see text-fig. 2). Another important point which should be noted is that this subgenus appears late in the stratigraphic sequence (Beds 2 and 3 of Mohan and Chatterji, 1956), and is absent in the older beds (Bhatia limestones, Bed 1).

EVOLUTION OF EQUATORIAL CHAMBERS

Tan (1936) and Bronnimann (1940) stressed the importance of the shape of the equatorial chambers in median section, and an evolutionary trend from arcuate through ogival, rhombic, and hexagonal to hexagonal-spatulate chambers was established. The arcuate type is the most primitive, and the hexagonal-spatulate type the most advanced. Tan's principle of nepionic acceleration was accepted by Bronnimann (1940) and by Drooger (1952). Drooger stated (1952, p. 63): "We see that this development roughly coincides with the development from simple lateral walls to distinct lateral chambers in more or less regular layers and tiers, with the change in

TABLE 2

DISTRIBUTION OF MIOGYPSINIDAE IN WESTERN INDIA

Species \ Localities	Kathiawar						Kutch	Surat-Broach
	B	D	F	Vf	H	Vwl	Vinjhan-Miani	Kimam-lee
Miogypsina (*Miogypsina*) *irregularis*	×	×	×	×		×	×	×
M. (*M.*) *bhogatensis* Mohan, n. sp.					×			
M. (*Lepidosemicyclina*) *droogeri* Mohan and Tewari, n. sp.							×	
M. (*L.*) *polymorpha*					×			
M. (*L.*) *thecideaeformis*				×				
M. (*L.*) cf. *thecideaeformis*								×

average shape of the equatorial chambers from arcuate to ogival, rhombic, and occasionally hexagonal, with the change from trochoid nepionic spirals to planispiral ones, with an irregular increase in the mean diameters of the embryonic chambers, and with the acquirement of a relatively larger size and kidney-shaped form of the deuteroconch." This principle is well demonstrated in the Indian Miogypsininae.

It is possible that all the different types of equatorial chambers may be found in a single specimen, but the predominance of one particular type may be of some help in generic and specific discrimination. *Lepidosemicyclina* Rutten is characterised by the predominance of hexagonal chambers. Similarly, the shape of the equatorial chambers is of some importance in distinguishing species. This point is illustrated below:

Miogypsina irregularis, variant *A*. — The equatorial chambers near the juvenarium are arcuate to arcuate-ogival, and in the later ontogenetic stages they are ogival to rhombic (predominance of arcuate-ogival chambers; see text-figure 1a–b).

Miogypsina irregularis, variant *B*. — The early equatorial chambers are ogival, but in later ontogenetic stages they become non-elongate to elongate-rhombic (predominance of non-elongate and rhombic chambers; see text-figure 1b–c).

Miogypsina bhogatensis Mohan, n. sp. — The equatorial chambers in the early ontogenetic stage are ogival-rhombic, but the later ones are extremely elongate-rhombic (predominance of elongate-rhombic chambers; see text-figure 1d).

Miogypsina (Lepidosemicyclina) thecideaeformis. — The early chambers are ogival, rhombic, and hexagonal, successively, but in the later ontogenetic stages the chambers are isodiametric-hexagonal (predominance of isodiametric-hexagonal chambers; see text-figure 1e).

Miogypsina (Lepidosemicyclina) polymorpha. — The early ontogenetic equatorial chambers are ogival-rhombic, but they soon become elongate-hexagonal (predominance of elongate-hexagonal chambers; see text-figure 1f).

Miogypsina (Leopidosemicyclina) droogeri Mohan and Tewari, n. sp. — The early ontogenetic stage with ogival-rhombic chambers is even shorter than in *M. (L.) polymorpha*, and is immediately followed by elongate-hexagonal chambers (predominance of elongate-hexagonal chambers; similar to the type shown in text-figure 1f).

TERMINOLOGY

External features

Apex: Defined as the part of the test generally containing the initial stage of the specimen.

Apical-frontal line: The line connecting the apex and the frontal periphery of the test.

Dimension: The diameter at right angles to the apical-frontal line in the broadest part of the test.

Internal features

Protoconch: Chamber I ("heteroconch" has been suggested in place of the term "protoconch"; see Schenck, 1944).

Deuteroconch: Chamber II.

Nucleoconch: Consists of Chambers I and II ("proloculus," according to Schenck, 1944).

Juvenarium: Consists of the nucleoconch and the nepionic or periembryonic chambers.

Periembryonic or nepionic chambers: All the chambers embracing the embryonic stage.

Abbreviations

D_i = Maximum diameter of protoconch (mean value M_i).

D_{ii} = Maximum diameter of deuteroconch (mean value M_{ii}).

$M200\alpha/\beta$ = Mean value of $200\alpha/\beta$.

$M\gamma$ = Mean value of $L\gamma$.

PROVENANCE OF MATERIAL

The samples for the present study were collected from six different localities in Kathiawar; from the Vinjhan-Miani area in Kutch; and from the Surat-Broach area. The distribution of the family Miogypsinidae in western India is shown in Table 2. The locations of the samples are as follows:

KATHIAWAR REGION

Bhogat and Bhatia area:

Bhatia village (69°16′ E., 22°06′ N.):
Locality B (Bhatia): One and one-half furlongs north of the Bhatia railway station.
Locality D (Bhatia): About one-half mile east of the Bhatia railway station.

Bhogat village (69°14′ E., 21°59′ N.):
Locality H (Bhogat): One and one-half miles N. 34° E. from the village of Bhogat.
Locality F (well near Bhogat): About one-half mile east of locality H (Bhogat).

Visawara village (69°27′ E., 21°46′ N.):
Locality Vf (Visawara): About two and one-half miles north of the village of Visawara.

Verawal area:

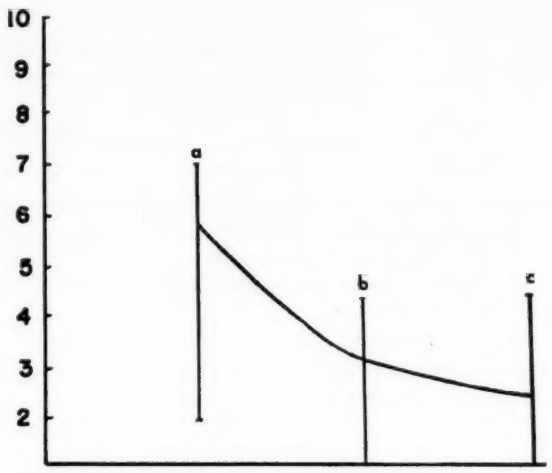
Khorasa village (70°22′ E., 22°03′ N.):
Locality Vwl (Verawal:) About one and one-half miles west of the village of Khorasa.

KUTCH REGION

Locality Vinjhan-Miani: In the neighbourhood of the villages of Vinjhan (69°02′ E., 23°06′ N.) and Miani (69°06′ E., 23°07′ N.).

SURAT-BROACH REGION

Locality Kimamlee: Kim River close to the village of Kimamlee, near Surat.



TEXT-FIGURE 2

First appearance of hexagonal chambers in rows with respect to the juvenarium: a, *Miogypsina* (*Lepidosemicyclina*) *thecideaeformis* (Rutten); b, *M.* (*L.*) *polymorpha* (Rutten); c, *M.* (*L.*) *droogeri* Mohan and Tewari, n. sp.

SYSTEMATIC DESCRIPTIONS

Order FORAMINIFERA

Family MIOGYPSINIDAE Tan, 1936

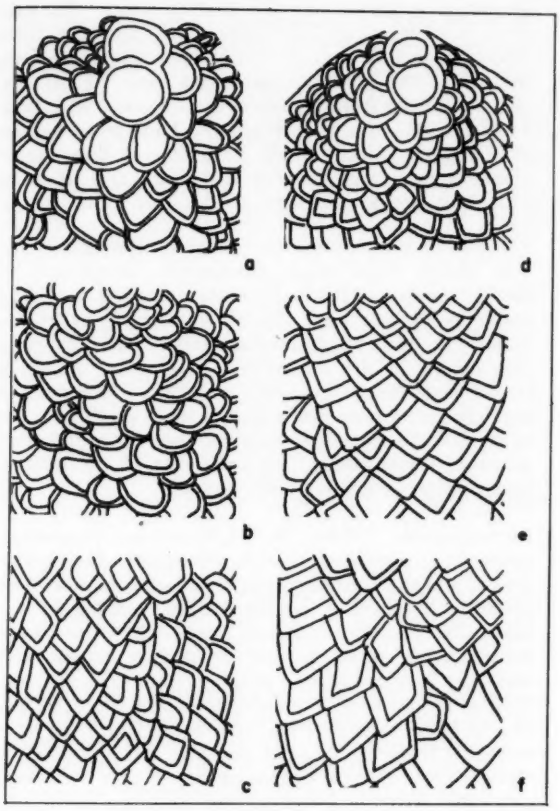
Subfamily MIOGYPSININAE Vaughan, 1928

Genus MIOGYPSINA Sacco, 1893, sensu lato

Subgenus MIOGYPSINA Sacco, 1893, sensu stricto

Miogypsina (Miogypsina) irregularis (Michelotti)

Nummulites irregularis MICHELOTTI, 1841, Soc. Ital. Sci. Modena, Mem., vol. 22, p. 296, pl. 3, fig. 5.
Nummulites globulina MICHELOTTI, 1841, *ibid.*, p. 297, pl. 3, fig. 6.
Gypsina (*Miogypsina*) *irregularis* (Michelotti). – DE AMICIS, 1894, Soc. Toscana Sci. Nat., Proc. Verb., vol. 9, pp. 136–139.
Gypsina (*Miogypsina*) *globulina* (Michelotti). – DE AMICIS, 1894, *ibid.*, vol. 9, pp. 136–139.
Miogypsina irregularis (Michelotti). – YABE AND HANZAWA, 1930, Tohoku Imp. Univ., Sci. Repts., ser. 2 (Geol.), vol. 14, no. 1, p. 35, pl. 11, figs. 2–5. – DAVID-SYLVAIN, 1937, Soc. Géol. France, Mém., new ser., vol. 15, fasc. 1, no. 33, p. 33, pl. 3, fig. 2. – BRONNIMANN, 1940, Mém. Suisses Pal., vol. 66, pp. 88–94, pl. 8, figs. 1–11; pl. 10, figs. 6–11; pl. 11, figs. 1, 4 (including synonymy). – DROOGER, 1952 (part), American Miogypsinidae, pp. 32–33 (nos. 19, 20, 21), pl. 2, figs. 25–29, tables 1–2. – DROOGER, 1954, K. Nederl. Akad. Wetensch., Proc., ser. B, vol. 57, no. 2, pp. 238–239, pl. 2, figs. 1–5; table 1.



TEXT-FIGURE 3

a–c, early to late ontogenetic stages in megalospheric specimen of *Miogypsina (Miogypsina) irregularis* (Michelotti), variant *A* from locality B; d–f, early to late ontogenetic stages in megalospheric specimens of *Miogypsina (Miogypsina) irregularis* (Michelotti), variant *B*, from locality B. All figures × ca. 60.6.

Miogypsina (Miogypsina) irregularis (Michelotti) is found in western India at localities B, D, F, Vf, Vinjhan-Miani, and Kimamlee. At localities B, D, and F it was found that the population of *Miogypsina irregularis* is not entirely homogeneous. The species can be divided into two variants: Variant *A* and variant *B*. Variant *A* seems to be a slightly older form or may represent contemporaneous individuals with a slight change in ecology.

In variant *A* the test is biconvex, highly inflated, ovoid, and isodiametric, while in variant *B* it is irregular, inflated, and fan-shaped; in variant *A* the granulations are much larger, the chambers of the embryonic apparatus are more often covered by the chambers of the main spire, and the value of $M\gamma$ is lower than in variant *B*. Notations in variant *B*: $6\frac{1}{2}$–$1\frac{1}{2}$ to $5\frac{1}{2}$–$1\frac{1}{2}$; $200\,\alpha/\beta = 25$ to 30. Variant *A* has primitive equatorial chambers and a larger number of lateral chamber layers.

VARIANT A

Plate 1, figures 1–10; text-figure 1a–b; text-figure 3a–c

Material: Forty specimens measured externally, twenty-eight studied in median section, and twelve in transverse section. No microspheric forms were observed.

Variation in external characters: Tests more or less ovoid in outline, the two diameters (the apical-frontal and the dimension) therefore nearly the same. At locality B the granulations are larger in the apical-central zone, ranging from 100μ to 300μ, and smaller toward the periphery, ranging from 50μ to 90μ; the larger diameter ranges from 2.52 mm. to 3.20 mm., and the thickness from 0.95 mm. to 1.35 mm. At locality D the granulations range from 60μ to 180μ; the larger diameter of the test from 1.00 mm. to 2.80 mm., and the thickness from 1.00 mm. to 1.20 mm. At locality F the granulations are larger in the apical-central zone (70μ to 150μ), and smaller toward the periphery (40μ to 80μ); the larger diameter ranges from 2.20 mm. to 2.90 mm., and the thickness from 0.83 mm. to 1.30 mm.

Variation in internal characters: Juvenarium peripheral, planispiral, consisting of a two-chambered nucleoconch and the periembryonic chambers; chamber I or protoconch spherical or subspherical, ranging from 133μ to 209μ ($M_i = 170\mu$); chamber II or deuteroconch ranging from 133μ to 228μ ($M_{ii} = 184\mu$); length of nucleoconch along its axis ranging from 247μ to 350μ (mean value 280μ), its wall thickness from 15μ to 30μ; nepionic chambers six to nine, in a more or less continuous spire, becoming gradually smaller in size from the main principal auxiliary chamber on; second principal auxiliary chamber present in most of the specimens. At locality B thirteen sections out of sixteen, at locality D four sections out of seven, and at locality F three sections out of five have a second principal auxiliary chamber, which is generally covered by the chambers of the main spire.

The value D_{II}/D_I ranges at locality B from 1.00 to 1.21, at locality D from 1.05 to 1.16, and at locality F from 1.00 to 1.15; $M\gamma = 8°$.

The equatorial chambers in the early ontogenetic stages are arcuate to arcuate-ogival, successively; in the central and frontal-peripheral zone, i.e., the later ontogenetic stages, the equatorial chambers are ogival to elongate-ogival, with a few layers of non-elongate and rhomboidal type; equatorial chambers primitive, mostly arcuate-ogival to ogival, their maximum diameters 95μ × 133μ to 144μ × 153μ.

The lateral chambers are arranged imbricately in six to nine layers, successively, in the thickest part of the test; height of equatorial chambers ranging from 120μ to 133μ; height of lateral chambers ranging from 65μ to 110μ; thickness of the roof from 20μ to 95μ (averaging 50μ to 80μ); lateral chamber walls thick; pillars distinct, with marked thickening of roofs and floors.

Number of sections	Notation or x	L γ
Locality B		
4	8/1	
1	9/1	
5	7/1	0°–25°
2	8	
3	6/1	
1	7	
Locality D		
3	7/1	
2	6/1	0°–10°
1	8	
2	6	
Locality F		
2	6/1	
2	7	0°–30°
1	7/1	

Distribution: Variant *A* of *Miogypsina (Miogypsina) irregularis* occurs at localities B, D, and F, in Kathiawar.

Variant B

Plate 1, figures 11–18; text-figure 1b–c; text-figure 3d–f; text-figure 6a–d

Material: About 200 specimens measured externally, seventy specimens studied in median sections, and twenty in transverse sections.

Variation in external characters: Microspheric (Form A): A few microspheric specimens were observed at locality B. Test irregular, planoconvex to concavoconvex; inflated at apex, outline fan-shaped; granulations larger in the apical-central zone, ranging from 70μ to 200μ, and smaller toward the periphery, ranging from 70μ to 140μ; apical-frontal diameter ranging from 3.30 mm. to 4.30 mm., dimension from 2.75 mm. to 3.75 mm., and thickness from 0.62 mm. to 1.25 mm.

Megalospheric (Form B): Test irregular, planoconvex to biconvex; inflated at the apex, outline fan-shaped; periphery smooth. At locality B, granulations larger around the apical-central zone (40μ to 140μ), and smaller toward the periphery (10μ to 60μ); apical-frontal diameter ranges from 1.02 mm. to 2.40 mm., dimension from 1.08 mm. to 2.40 mm., and thickness from 0.25 mm. to 0.95 mm. At locality D, granulations range from 40μ to 170μ, apical-frontal diameter from 1.60 mm. to 2.60 mm., and thickness from 0.40 mm. to 0.70 mm. In thirteen specimens examined from locality F, the granulations vary from 40μ to 100μ, apical-frontal diameter from 1.60 mm. to 2.60 mm., dimension from 1.20 mm. to 2.35 mm., and thickness from 0.40 mm. to 0.70 mm. In nine specimens from locality Vwl, the granulations vary from 40μ to 100μ, larger diameter from 1.50 mm. to 2.20 mm., and thickness from 0.45 mm. to 0.83 mm. At locality Vf, the granulations vary from 40μ to 80μ, larger diameter from 1.50 mm. to 2.50 mm., and thickness from 0.45 mm. to 0.83 mm. At the locality Vinjhan-Miani, the size of the granulations ranges from 36μ to 91μ, larger diameter from 0.90 mm. to 1.73 mm., and thickness from 0.31 mm. to 0.60 mm. At Kimamlee, the size of the granulations varies from 60μ to 80μ, larger diameter from 1.90 mm. to 2.50 mm., and thickness from 0.50 mm. to 0.65 mm.

Variation in internal characters: Microspheric (Form A): The initial stage small, planispiral, peripheral; in median section, equatorial chambers small (51μ × 76μ) and non-elongate near the initial stage, ogival-rhomboidal in the apical-central zone, and elongate-rhomboidal in the frontal-peripheral zone, attaining maximum dimensions (190μ × 285μ). Sometimes a few chambers on the apical-frontal periphery are hexagonal. In transverse sections, three or four lateral chamber layers present on each side of the median layer; pillar thickening feebly marked.

Megalospheric (Form B): Juvenarium peripheral, planispiral, consisting of two chambers, the nucleoconch, and the periembryonic chambers; chamber I or protoconch spherical to subspherical, ranging in size from 75μ to 171μ (M_I = 136μ); chamber II or deuteroconch equal in size or slightly larger, and distinctly kidney-shaped, ranging from 95μ to 190μ (M_{II} = 156μ); length of the nucleoconch along its axis ranges from 152μ to 330μ (averaging 229μ), its wall thickness from 9μ to 24μ; nepionic chambers six to eight; most of the specimens have two principal auxiliary chambers, the second principal auxiliary chamber smaller than the first, seldom covered by chambers of the main protoconchal spire; the protoconchal spire produced by the main principal auxiliary chamber is much larger than that produced by the second principal auxiliary chamber; the value of the symmetry of the two protoconchal spires, which is expressed by 200α/β, ranges from 17 to 48 (averaging 25 to 30). The value of L γ ranges from 10° to 55° (Mγ = 25° to 35°); D_{II}/D_I = 1.1 to 1.3.

At locality Vinjhan-Miani, the length of the nucleoconch along its axis ranges from 152μ to 171μ; protoconch from 85μ to 95μ; deuteroconch from 85μ to 114μ; notation or x = 6; 200 α/β in two sections 26 to 56; M γ = 10°. At Kimamlee (Surat-Broach), length of nucleoconch along its axis ranges from 150μ to 240μ; protoconch 86μ to 130μ; deuteroconch from 112μ to 180μ; notation or x = 5 to 7; 200 α/β = 26 (one section).

The equatorial chambers near the juvenarium are ogival to ogival-rhomboidal, and are followed by completely rhomboidal chambers toward the frontal periphery. The rhomboidal chambers in some cases are broader than long, in others they are isodiametric, and in others elongate. At localities B, D, and F, the equatorial chambers are mostly non-elongate and

Number of sections	Notation or x	200 α/β	L γ
Locality B			
11	$6\frac{1}{2}$–$1\frac{1}{2}$		
7	$5\frac{1}{2}$–$1\frac{1}{2}$		
1	$7\frac{1}{2}$–$1\frac{1}{2}$		
1	$4\frac{1}{2}$–$1\frac{1}{2}$	15–43	10°–55°
5	7		
4	6		
Locality D			
3	$6\frac{1}{2}$–$1\frac{1}{2}$		
2	$5\frac{1}{2}$–$1\frac{1}{2}$	25–33	20°–28°
Locality F			
3	$5\frac{1}{2}$–$1\frac{1}{2}$		
2	$4\frac{1}{2}$–$1\frac{1}{2}$	35–48	10°–40°
2	7		
Locality Vf			
4	$5\frac{1}{2}$–$1\frac{1}{2}$		
3	$4\frac{1}{2}$–$1\frac{1}{2}$	15–45	0°–40°
2	6		
Locality Vwl			
1	$5\frac{1}{2}$–$1\frac{1}{2}$	20	30°–40°
3	6		

isodiametric; at localities Vf and Vwl, the chambers vary from isodiametric to elongate-rhomboidal. The maximum diameter of the chambers ranges from 95μ × 133μ to 190μ × 228μ. Occasionally a few hexagonal chambers are observed toward the frontal periphery. At the locality Vinjhan-Miani, the maximum diameter ranges from 114μ × 190μ to 114μ × 228μ, and at Kimamlee (Surat-Broach) from 90μ × 150μ to 102μ × 150μ.

The stolon passages observed in a few specimens are mostly bifold, two stolons being developed from each side of the chamber. A detailed study is not possible as the preservation is not good.

In transverse sections, the lateral chambers are arranged imbricately in three to four layers, successively, in the thickest part of the test, with the height of the median chambers well marked, ranging from 114μ to 156μ (average 133μ), and the roof 20μ to 51μ (average 38μ); height of the lateral chambers from 58μ to 120μ (average 80μ), and the roof from 19μ to 40μ (average 35μ); pillars present but not marked, no thickening observed; height of protoconch from 105μ to 190μ, of the deuteroconch from 95μ to 171μ. In specimens from the localities Vinjhan-Miani and Kimamlee, three to four layers of lateral chambers are present.

Distribution: Variant *B* of *Miogypsina (Miogypsina) irregularis* was found at localities B, D, F, Vf, and Vwl, in Kathiawar; at Vinjhan-Miani in Kutch; and at Kimamlee in Surat-Broach.

Miogypsina (Miogypsina) bhogatensis Mohan, **new species**

Plate 2, figures 1–7; text-figure 1d; text-figure 4a–c; text-figure 7a–h

Holotype: Specimen shown in plate 2, figure 3, and text-figure 7h.

Material: Seven specimens measured externally, ten specimens studied in median section, three in lateral section. No microspheric forms were observed.

Diagnosis: Test small, irregular, biconvex, strongly inflated at the apex, thinning gradually toward the periphery; periphery thin, papery and slightly frilled; surface bearing granulations; embryonic apparatus peripheral, planispiral; two principal auxiliary chambers always present, main principal auxiliary chamber larger than the second; nepionic chambers six to eight; M 200α/β = 45; mean value of L γ 10°; equatorial chambers elongate-rhomboidal; lateral chambers much compressed.

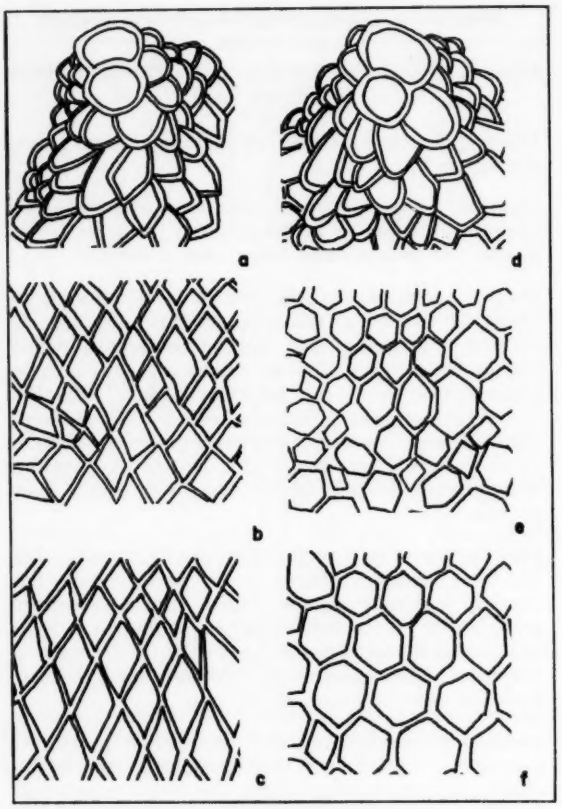
Variation in external characters: Test small, irregular, thin, biconvex, strongly inflated at the apex; outline fan-shaped; periphery slightly frilled, thin and papery; granulations on the surface ranging from 30μ to 180μ; apical-frontal diameter ranging from 2.37 mm. to 3.00 mm.; dimension from 2.00 mm. to 3.00 mm.; thickness from 0.65 mm. to 1.12 mm.

Variation in internal characters: Juvenarium peripheral, planispiral, consisting of two chambers, the nucleoconch, and the periembryonic chambers; protoconch spherical to subspherical, from 95μ to 152μ (M_I=118μ), followed by a kidney-shaped deuteroconch of slightly larger size, which ranges from 95μ to 171μ (M_{II}=130μ); the ratio between their larger diameters (D_{II}/D_I) ranges from 1.10 to 1.45; length of embryonic apparatus along its axis averaging 199μ, its wall thickness 12μ to 18μ; nepionic chambers seven or eight, always with two principal auxiliary chambers; the notations in ten sections are: $5\frac{1}{2}$–$1\frac{1}{2}$ in four sections, $4\frac{1}{2}$–$2\frac{1}{2}$ and $4\frac{1}{2}$–$1\frac{1}{2}$ in two sections each, and $4\frac{1}{2}$–$1\frac{1}{2}$ and $5\frac{1}{2}$–$2\frac{1}{2}$ in one section each; the symmetry of the two protoconchal spires (200α/β) ranges from 24 to 80 (M200α/β = 45); Mγ = 10°.

The equatorial chambers near the juvenarium are ogival to non-elongate and rhomboidal, but toward the periphery and centre they are very elongate; maximum development 133μ × 228μ.

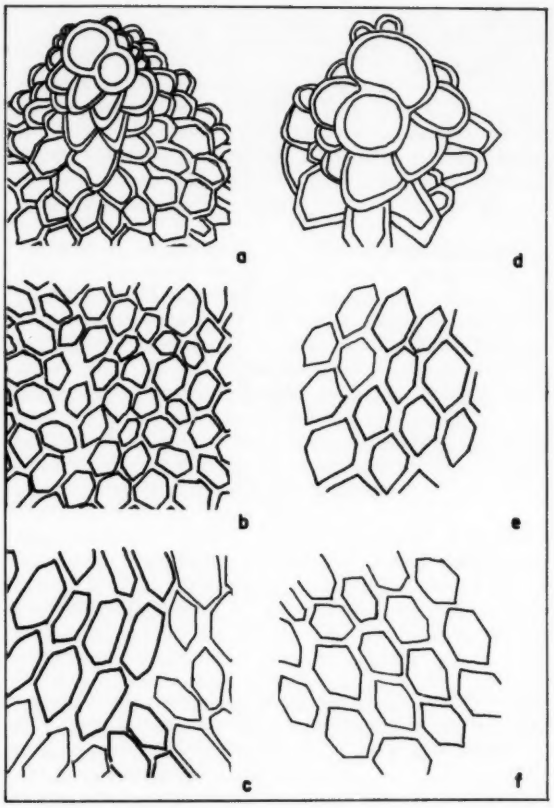
The lateral chambers are arranged in four to seven layers, successively, in the thickest portion of the test. They are compressed, but are inflated toward the apical zone.

Discussion: The species is associated with *Miogypsina (Lepidosemicyclina) polymorpha* at locality H (Bhogat). It differs from *M. (L.) polymorpha* externally in having a thin and uncrumpled periphery and a very much in-



TEXT-FIGURE 4

a–c, early to late ontogenetic stages in megalospheric specimens of *Miogypsina (Miogypsina) bhogatensis* Mohan, n. sp., from locality H; d–f, early to late ontogenetic stages in megalospheric specimens of *Miogypsina (Lepidosemicyclina) thecideaeformis* (Rutten), from locality Vf. All figures × ca. 60.6.



TEXT-FIGURE 5

a–c, early to late ontogenetic stages in megalospheric specimens of *Miogypsina (Lepidosemicyclina) polymorpha* (Rutten), from locality H; d–f, early to late ontogenetic stages in megalospheric specimens of *Miogypsina (Lepidosemicyclina) droogeri* Mohan and Tewari, n. sp., from locality Vinjhan-Miani. All figures × ca. 60.6.

flated apex, internally in having fewer hexagonal chambers and a much lower value of $L\gamma$. In the values of $200\,\alpha/\beta$, this species is very similar to *Miogypsina kotoi* Hanzawa. It differs from *Miogypsina kotoi* in having a thin periphery throughout, an inflated apical zone, elongate-rhombic equatorial chambers, and compressed and numerous lateral chamber layers.

Remarks: The species is named after the village of Bhogat (locality H), where it occurs in abundance.

Type locality: The species occurs only at locality H (Bhogat village), in the Kathiawar region.

Age: Burdigalian.

Repository: Geology Museum, University of Lucknow; holotype, no. MBH 8.

Subgenus LEPIDOSEMICYCLINA Rutten, 1911

Miogypsina (Lepidosemicyclina) thecideaeformis (Rutten)

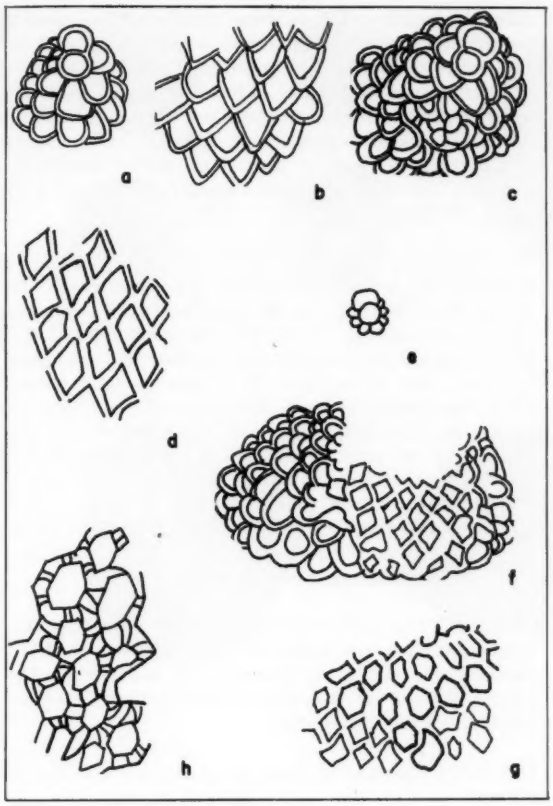
Plate 2, figures 8–13; text-figure 1e; text-figure 4d–f

Orbitoides (Lepidosemicyclina) thecideaeformis RUTTEN, 1911, K. Akad. Wetensch. Amsterdam, Wis- en Natuurk. Afd., Versl., vol. 19, pt. 2, pp. 1157–1158.

Miogypsina thecideaeformis (Rutten). – RUTTEN, 1912, Geol. Reichs-Mus. Leiden, Samml., ser. 1, vol. 9, no. 2, p. 204, pl. 12, figs. 1–5.

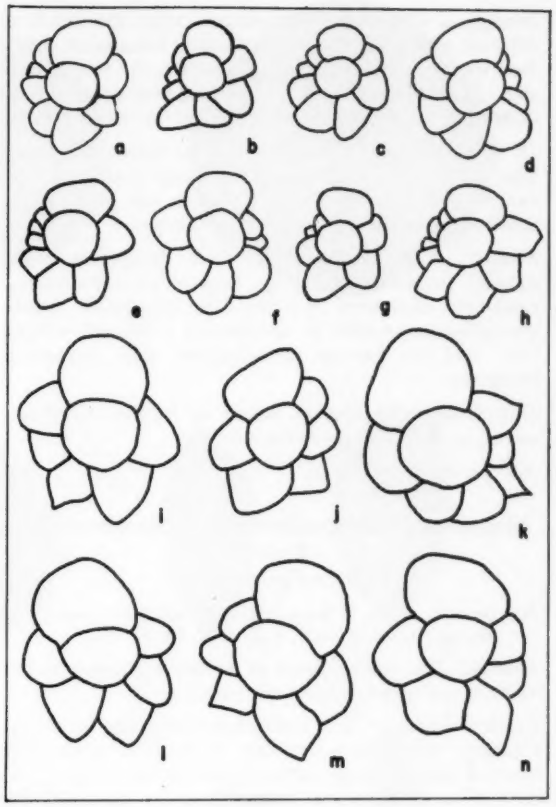
Miogypsina (Miogypsina) thecideaeformis (Rutten). – TAN SIN HOK, 1937, Ingenieur Nederl.-Indië, vol. 4, no. 3, pt. 4, p. 38, pl. 1, figs. 9, 11, 13; pl. 2, fig. 15; pl. 3, figs. 10, 11a–b (including synonymy).

Miogypsina thecidaeformis [*sic*] (Rutten). – DROOGER, 1953, K. Nederl. Akad. Wetensch., Proc., ser. B, vol. 56, no. 1, pp. 109–110, pl. 1, figs. 10–14, 32.



TEXT-FIGURE 6

a–b, early to late ontogenetic stages in megalospheric specimens of *Miogypsina (Miogypsina) irregularis* (Michelotti), from locality Vinjhan-Miani; c–d, early to late ontogenetic stages in megalospheric specimens of *Miogypsina (Miogypsina) irregularis* (Michelotti), from locality Kimamlee; e–h, early to late ontogenetic stages in megalospheric specimens of *Miogypsina (Lepidosemicyclina)* cf. *thecideaeformis* (Rutten), from locality Kimamlee. All figures × ca. 60.6.



TEXT-FIGURE 7

a–h, juvenaria of megalospheric specimens of *Miogypsina (Miogypsina) bhogatensis* Mohan, n. sp., from locality H: h, juvenarium of the holotype; i–n, juvenaria of megalospheric specimens of *Miogypsina (Lepidosemicyclina) droogeri* Mohan and Tewari, n. sp., from locality Vinjhan-Miani: j, juvenarium of the holotype. All figures × ca. 60.6.

Material: Eight specimens were measured externally, ten specimens studied in median section, and three specimens studied in lateral section. No microspheric individuals were observed.

Variation in external characters: Test resembling *Miogypsina (Miogypsina) irregularis* but considerably larger, irregular in shape, unequally biconvex, inflated in the apical-central zone; outline invariably fan-shaped; periphery smooth; granulations larger in the apical-central zone and smaller toward the periphery, ranging from 40μ to 160μ; apical-frontal diameter ranging from 2.10 mm. to 5.10 mm., thickness from 0.50 mm. to 0.90 mm.

Variation in internal characters: Juvenarium peripheral, planispiral, consisting of a two-chambered nucleoconch (protoconch and deuteroconch) and the periembryonic chambers; protoconch spherical, ranging from 152μ to 190μ ($M_I = 153\mu$); deuteroconch typically kidney-shaped, ranging from 152μ to 228μ ($M_{II} = 173\mu$); length of nucleoconch along its axis averaging 264μ, its wall thickness 15μ to 20μ; nepionic chambers six to eight; two principal auxiliary chambers always present, second principal auxiliary chamber much smaller than the first; chambers of the main spire gradually becoming smaller toward the second principal auxiliary chamber; the notations in eight sections are: $5\frac{1}{2}$–$1\frac{1}{2}$ in five sections, $4\frac{1}{2}$–$1\frac{1}{2}$ in two sections, and $6\frac{1}{2}$–$1\frac{1}{2}$ in one section; value of $200\alpha/\beta$ ranging from 33 to 56 ($M200\alpha/\beta = 37$); value of $\angle\gamma$ ranging from 30° to 58° ($M\gamma = 38°$); $M_{II}/M_I = 1.21$.

The equatorial chambers near the embryonic apparatus (three to four rows) are ogival, changing later from ogival to rhombic and then to hexagonal, successively;

hexagonal chambers predominate after the tenth to fifteenth row beyond the juvenarium; hexagonal chambers mostly non-elongate, isodiametric, the variation in size not as marked as in *M.* (*L.*) *polymorpha;* maximum diameter ranging from 150μ × 190μ to 209μ × 228μ.

In transverse section the height of the equatorial chambers is 114μ to 133μ; lateral chambers imbricately arranged in four to five layers on either side of the equatorial layer in the thickest part of the test.

Remarks: This species differs from *Miogypsina* (*Miogypsina*) *irregularis* in having hexagonal (isodiametric) equatorial chambers. It differs from *Miogypsina* (*Lepidosemicyclina*) *polymorpha* in not having a twisted, winged test, and in having non-elongate and hexagonal chambers.

Distribution: This species occurs at locality Vf (Visawara), in the Kathiawar region.

Age: Lower Burdigalian.

Miogypsina (Lepidosemicyclina) cf. **thecideaeformis**
(Rutten)
Text-figure 6e–h

Miogypsina sp., S. R. N. Rao, 1941, Mysore Univ., Jour., new ser., sec. B, vol. 2, no. 1, p. 7, pl. 2, fig. 5.

Material: The identification of this form is based on the study of a single available specimen.

External characters: Test somewhat unequally biconvex, elongate, fan-shaped, smooth in outline, apex well marked and inflated, with frontal margin slightly indented; larger diameter 3 mm. along the apical-frontal line, thickness 0.80 mm.; surface ornamentation not very distinct.

Internal characters: Juvenarium peripheral, planispiral, consisting of a two-chambered nucleoconch and the periembryonic chambers; protoconch 60μ, followed by the deuteroconch, slightly kidney-shaped in form, 90μ in its larger diameter; ratio between larger diameters of deuteroconch and protoconch (D_{II}/D_I) 1.25; length of nucleoconch along its axis 100μ; wall thickness 6μ; nepionic chambers arranged regularly (notation $5\frac{1}{2}$–$1\frac{1}{2}$; value of $200\alpha/\beta = 40$; $\angle\gamma = 10^0$).

The equatorial chambers, which are successively ogival to hexagonal, are well marked on the right and left sides of the early chambers in the apical-central zone; near the juvenarium they are rhomboidal to hexagonal. Most of the equatorial chambers are isodiametric-hexagonal, but they show a tendency to become elongate toward the frontal periphery, as in *Miogypsina* (*Lepidosemicyclina*) *polymorpha*. The short hexagonal chambers become dominant after ten rows of alternately ogival-rhombic and hexagonal chambers, and sometimes in the frontal-peripheral zone there are a few elongate-hexagonal to spatulate-hexagonal equatorial chambers. The larger chambers measure 120μ × 160μ. Stolon system two-fold, lateral chambers present.

Discussion: The nucleoconch of the described specimen is much smaller than that of the type specimen of *M.* (*L.*) *thecideaeformis*. *M.* (*L.*) cf. *thecideaeformis* differs from *Miogypsina* (*Miogypsina*) *irregularis* in having most of its equatorial chambers hexagonal.

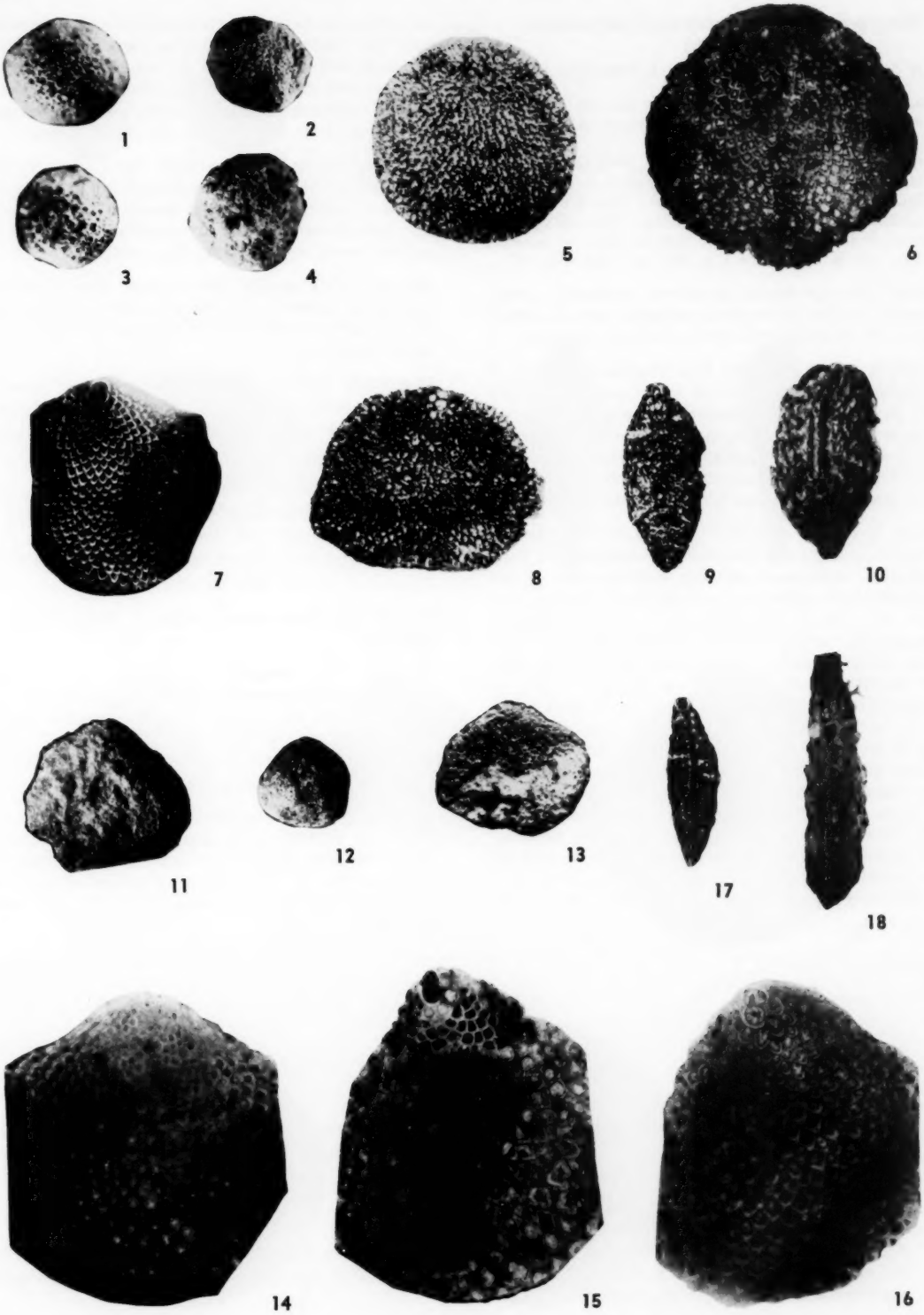
Distribution: Kimamlee, near Surat, in the Surat-Broach region.

Age: Lower Burdigalian.

PLATE 1

1–10 *Miogypsina (Miogypsina) irregularis* (Michelotti), variant *A*
1–3, tests of megalospheric specimens from locality B, × ca. 5.3; 4, test of a megalospheric specimen from locality D, × 8; 5, 8, median sections of megalospheric specimens from locality B, × ca. 12.6; 6–7, median sections of megalospheric specimens from locality D, × ca. 16.6; 9, transverse section of a megalospheric specimen from locality B, × ca. 17.3; 10, transverse section of a megalospheric specimen from locality B, × ca. 11.3.

11–18 *Miogypsina (Miogypsina) irregularis* (Michelotti), variant *B*
11, test of a microspheric specimen, × ca. 2.6; 12–13, tests of megalospheric specimens, × ca. 6.6; 14, median section of a microspheric specimen, × 20; 15–16, median sections of megalospheric specimens, × 28; 17, transverse section of a megalospheric specimen, × 10; 18, transverse section of a megalospheric specimen, × ca. 21.3. All specimens from locality B.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Miogypsina (Lepidosemicyclina) polymorpha
(Rutten)
Plate 3, figures 1–8; text-figure 1f; text-figure 5a–c

Orbitoides (Lepidosemicyclina) polymorpha RUTTEN, 1911, K. Akad. Wetensch. Amsterdam, Wis- en Natuurk. Afd., vol. 19, pt. 2, pp. 1159–1160.
Miogypsina polymorpha (Rutten). – RUTTEN, 1912, Geol. Reichs-Mus. Leiden, Samml., ser. 1, vol. 9, no. 2, p. 207, pl. 12, figs. 6–9. – HANZAWA, 1940, Tohoku Imp. Univ., Yabe Jubilee Publ., vol. 2, p. 785, pl. 40, fig. 1 (including synonymy). – DROOGER, 1953, K. Nederl. Akad. Wetensch., Proc., ser. B, vol. 56, no. 1, p. 106, pl. 1, figs. 1–4, 31.

Material: Six specimens measured externally, seven specimens studied in median sections, two in lateral sections. No microspheric specimens were observed.

Variation in external characters: Test irregular, typically of the "*polymorpha*" type; outline fan-shaped; periphery frilled, twisted, winged, indented, with undulations connected radially to the apex; granulations on the surface of the test 40μ to 100μ; apical-frontal diameter ranging from 2.70 mm. to 3.60 mm., dimension from 1.75 mm. to 3.10 mm., and thickness from 0.65 mm. to 1.00 mm.

Variation in internal characters: The early chambers or juvenarium peripheral, planispiral, consisting of a two-chambered nucleoconch and the periembryonic chambers; protoconch spherical to subspherical, ranging from 114μ to 152μ (M_I = 132μ), followed by a kidney-shaped deuteroconch ranging from 143μ to 209μ (M_{II} = 167μ); ratio of deuteroconch to protoconch (M_{II}/M_I) in their larger diameters 1.29; length of nucleoconch along its axis from 176μ to 323μ, averaging 257μ, its wall thickness 15μ to 30μ; nepionic chambers six to eight, much larger in the line of the apical-frontal axis; two principal auxiliary chambers always present. First principal auxiliary chamber followed by two or three chambers of very large dimensions, after which the chambers abruptly become very small; notations in six sections: $6\frac{1}{2}$–$1\frac{1}{2}$ and $4\frac{1}{2}$–$2\frac{1}{2}$ in two sections each, $4\frac{1}{2}$–$1\frac{1}{2}$ and $6\frac{1}{2}$–$2\frac{1}{2}$ in one section each; value of 200α/β ranging from 36 to 62 (M200α/β = 46); value of $\angle\gamma$ from 30° to 65° (M_γ = 44°).

In median section, the equatorial chambers are hexagonal. The early equatorial chambers are slightly less elongate and are arranged in more or less concentric rows around the early ones, but the later chambers become elongate-hexagonal, ranging in their maximum dimensions from 90μ × 114μ to 152μ × 228μ.

In transverse or lateral sections, the equatorial chambers appear to be elongate-hexagonal in shape with rounded angles, their height between 114μ and 133μ. The lateral chambers are arranged imbricately in three or four layers, ranging from 76μ to 90μ.

Remarks: This species differs from *Miogypsina (Miogypsina) irregularis* in having a twisted, winged, undulating, and indented test and elongate-hexagonal equatorial chambers.

Distribution: The species was found only at locality H (Bhogat), in the Kathiawar region, where it is associated with *Miogypsina (Miogypsina) bhogatensis* Mohan, n. sp.

Age: Burdigalian.

Miogypsina (Lepidosemicyclina) droogeri
Mohan and Tewari, **new species**
Plate 3, figures 9–12; text-figure 1f; text-figure 5d–f; text-figure 7i–n

Holotype: Specimen shown in plate 3, figure 9, and text-figure 7j.

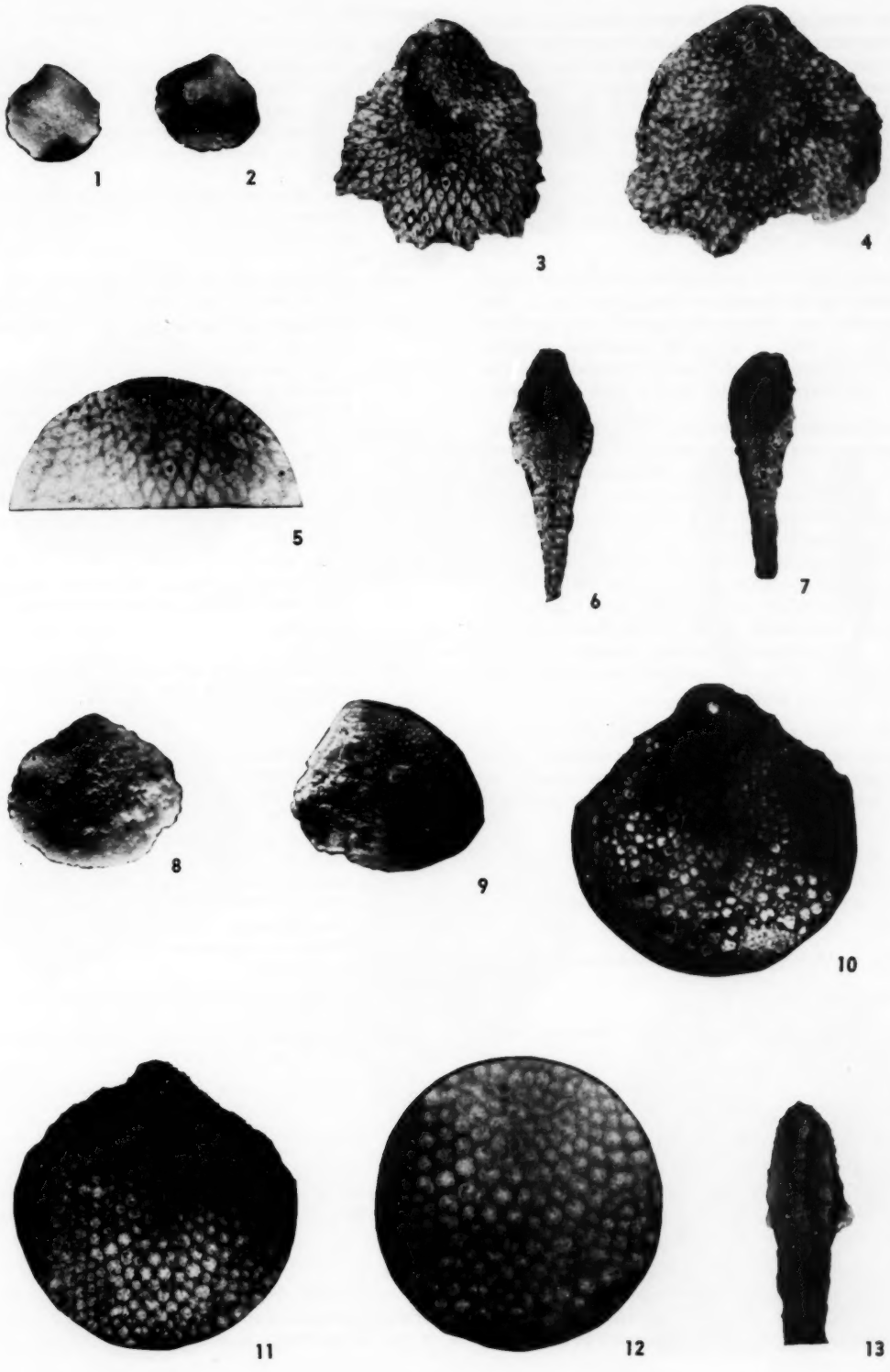
Diagnosis: Test irregular, fan-shaped, surface bearing granulations; juvenarium peripheral, planispiral; nepionic chambers five or six; the two principal auxiliary chambers of nearly equal size, the two protoconchal spires nearly symmetrical (M200α/β = 83); equatorial chambers elongate-hexagonal.

Variation in external characters: Test irregular, biconvex, sometimes inflated at the apex; outline fan-shaped; periphery smooth; granulations on the surface of test ranging from 90μ to 125μ; larger diameter ranging from 1.82 mm. to 3.56 mm., thickness from 0.35 mm. to 0.63 mm.

PLATE 2

1–7 *Miogypsina (Miogypsina) bhogatensis* Mohan, n. sp.
1–2, tests of megalospheric specimens, × 8; 3, holotype, a megalospheric specimen, median section, × ca. 16.6; 4, median section of a megalospheric specimen, × ca. 16.6; 5, equatorial chambers of a megalospheric specimen, × ca. 26.6; 6–7, transverse sections of megalospheric specimens, × ca. 26.6. All specimens from locality H.

8–13 *Miogypsina (Lepidosemicyclina) thecideaeformis* (Rutten)
8–9, tests of megalospheric specimens, × 8; 10–11, median sections of megalospheric specimens, × ca. 16.6; 12, equatorial chambers of a megalospheric specimen, × ca. 33.3; 13, transverse section of a megalospheric specimen, × ca. 16.6. All specimens from locality Vf.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Variation in internal characters: The early chambers consist of a two-chambered nucleoconch and the periembryonic chambers; protoconch rounded to subspherical, 171μ to 209μ; deuteroconch kidney-shaped, ranging from 209μ to 295μ; D_{II}/D_I ranging from 1.2 to 1.5; length of the nucleoconch along its axis ranging from 304μ to 409μ; nepionic chambers five or six, the two principal auxiliary chambers more or less similar; the notations in seven sections are: $2\frac{1}{2}$–$2\frac{1}{2}$ in five sections, and $3\frac{1}{2}$–$2\frac{1}{2}$ in two; $M200\alpha/\beta = 83$, the values ranging from 73 to 100; value of $L\gamma = 0°$ to 35°.

The equatorial chambers in the early ontogenetic stages are somewhat ogival-rhombic to hexagonal, but in the later stages they are elongate-hexagonal, ranging from 114μ × 190μ to 209μ × 247μ. In transverse sections, the lateral chambers are imbricately arranged in four to six layers, successively, in the thicker part of the test.

Discussion: Considering the value of $200\alpha/\beta$, this species is characterised by a nepionic apparatus that is closely similar to that of *Miogypsina* (*Miogypsina*) *cushmani* Vaughan. It differs from *Miogypsina* (*Lepidosemicyclina*) *thecideaeformis* and *M.* (*L.*) *polymorpha* in having a much higher value of $M200\alpha/\beta$ (greater than 70). The shape of the equatorial chambers is intermediate between those of the two Indonesian species, and is almost identical with that of *M.* (*L.*) *polymorpha* from Kathiawar. The species is most similar to *M.* (*L.*) *excentrica* Tan, but differs in having accessory auxiliary chambers around the deuteroconch. The new species is no doubt a descendant of *M.* (*L.*) *thecideaeformis*.

This species differs morphologically from the members of *Miogypsina sensu stricto* with which it is associated (*Miogypsina irregularis*) not only in having elongate-hexagonal chambers but also in the arrangement of the nepionic chambers.

Remarks: The species has been named in honour of Dr. C. W. Drooger. The authors have benefited greatly from his knowledge and thorough understanding of the miogypsines.

Type locality: Bed 4, Vinjhan-Miani, southwestern Kutch.

Age: Burdigalian.

Repository: Geology Museum, Lucknow University; holotype, no. LDK 2.

REFERENCES

BARKER, R. W.
1932 – *Three species of larger foraminifera from S.W. Ecuador.* Geol. Mag., vol. 69, pp. 277–281.

BARKER, R. W., AND GRIMSDALE, T. F.
1937 – *Studies of Mexican fossil foraminifera.* Ann. Mag. Nat. Hist., ser. 10, vol. 19, pp. 161–178.

BRONNIMANN, P.
1940 – *Über die tertiären Orbitoididen und die Miogypsiniden von Nordwest-Marokko.* Schweiz. Pal. Abh., vol. 63, no. 1, pp. 1–113.

COLE, W. S.
1938 – *Stratigraphy and micropaleontology of two deep wells in Florida.* Florida, Geol. Survey, Bull., vol. 16, pp. 1–73.
1941 – *Stratigraphic and paleontologic studies of wells in Florida.* Ibid., vol. 19, pp. 1–91.
1945 – *Larger foraminifera.* In: LADD, H. S., AND HOFFMEISTER, J. E., *The geology of Lau, Fiji.* Bernice P. Bishop Mus., Bull., no. 181, pp. 272–297.

CUSHMAN, J. A.
1918 – *The larger foraminifera of the Panama Canal Zone.* U. S. Nat. Mus., Bull., no. 103, pp. 89–102.
1948 – *Foraminifera, their classification and economic use.* Ed. 4. Cambridge, Mass.: Harvard University Press, pp. 3–605.

DAVID-SYLVAIN, E.
1937 – *Étude sur quelques grands foraminifères tertiaires.* Soc. Géol. France, Mém., new ser., vol. 15, fasc. 1, no. 33, pp. 5–44.

DE AMICIS, G. A.
1894 – *Osservazione critiche sopra talune Tinoporinae fossili.* Soc. Toscana Sci. Nat. Pisa, Atti Proc. Verb., vol. 9, pp. 136–141.

DROOGER, C. W.
1951*a* *Foraminifera from the Tertiary of Anguilla, St. Martin and Tintamarre (Leeward Islands, West Indies).* K. Nederl. Akad. Wetensch. Amsterdam, Proc., ser. B, vol. 54, no. 1, pp. 53–65.
1951*b* *Notes on some representatives of Miogypsinella.* Ibid., ser. B, vol. 54, no. 4, pp. 357–365.
1952 – *Study of American Miogypsinidae.* (Utrecht, Univ., doct. diss.) Zeist, Netherlands: The author, pp. 1–80.
1953 – *Some Indonesian Miogypsinae.* K. Nederl. Akad. Wetensch. Amsterdam, Proc., ser. B, vol. 56, no. 1, pp. 104–123.
1954*a* *Miogypsina in northern Italy.* Ibid., ser. B, vol. 57, no. 2, pp. 249–277.
1954*b* *Miogypsina in northwestern Morocco.* Ibid., ser. B, vol. 57, no. 5, pp. 580–591.

PLATE 3

1–8 *Miogypsina (Lepidosemicyclina) polymorpha* (Rutten)
1–2, tests of megalospheric specimens, × 8; 3–5, median sections of megalospheric specimens, × ca. 16.6; 6, equatorial chambers of a megalospheric specimen, × ca. 26.6; 7–8, transverse sections of megalospheric specimens, × ca. 16.6. All specimens from locality H.

9–12 *Miogypsina (Lepidosemicyclina) droogeri* Mohan and Tewari, n. sp.
9, holotype, a megalospheric specimen, median section, × ca. 23.3; 10, median section of a megalospheric specimen, × ca. 30.6; 11, the early ontogenetic stages of a megalospheric specimen, × ca. 66.6; 12, transverse section of a megalospheric specimen in a rock section, × 40. All specimens from the locality Vinjhan-Miani.

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GRAVELL, D. W.
1933 – *Tertiary larger foraminifera of Venezuela.* Smithsonian Inst., Misc. Coll., vol. 89, no. 11, pp. 1–44.

HANZAWA, S.
1931 – *Notes on Tertiary foraminiferous rocks from the Kwantô Mountainland, Japan.* Tohoku Imp. Univ., Sci. Repts., ser. 2 (Geol.), vol. 12, no. 2A, pp. 141–157.

1935 – *Some fossil Operculina and Miogypsina from Japan and their stratigraphical significance.* Ibid., vol. 18, no. 1, pp. 1–29.

1938 – *Studies on the foraminiferal fauna found in the bore cores from the deep well in Kita-Diatozima (North Borodino Island).* Imp. Acad. Japan, Proc., vol. 14, no. 10, pp. 384–390.

1940 – *Micropaleontological studies of drill cores from a deep well in Kita-Diatozima (North Borodino Island).* In: *Jubilee Publication in Commemoration of Prof. H. Yabe's 60th Birthday.* Sendai, Japan: Tohoku Imp. Univ., vol. 2, pp. 755–802.

1947 – *Reinstatement of the genus Heterosteginoides and the classification of the Miogypsinidae.* Jour. Pal., vol. 21, pp. 260–263.

MOHAN, K.
[MS.] *Geology of parts of Kathiawar with studies on the Miogypsinidae of western India.* (Lucknow, Univ., doct. diss., 1954, unpublished.)

MOHAN, K., AND CHATTERJI, A. K.
1956 – *Stratigraphy of the Miocene beds of Kathiawar, western India.* Micropaleontology, vol. 2, no. 4, pp. 349–356, text-figs. 1–3, table 1.

RAO, S. R. N., TEWARI, B. S., MOHAN, K., AND CHATTERJI, A. K.
1957 – *The Miocene of western India.* Geol. Mag., vol. 94, no. 1, pp. 81–86.

RUTTEN, L. M. R.
1911 – *Over Orbitoiden uit de omgeving der Balik Papan-Baai, Oostkust van Borneo.* K. Akad. Wetensch. Amsterdam, Wis- en Natuurk. Afd., Versl., vol. 19, pt. 2, pp. 1143–1161.

1912 – *Studien über Foraminiferen aus Ost-Asien.* Leiden, Geol. Reichs-Mus., Samml., ser. 1, vol. 9, pp. 201–217.

1926 – *Over Tertiare, foraminiferen houdende gesteenten uit Beraoe (Oost-Borneo).* Geol.-Mijnb. Gen. Nederland en Kol., Verh., Geol. Ser., no. 7, pp. 297–328.

SCHENCK, H. G.
1944 – *Proloculus in foraminifera.* Jour. Pal., vol. 18, no. 3, pp. 275–283.

TAN SIN HOK
1932 – *On the genus Cycloclypeus Carpenter, Part I; and an appendix on the heterostegines of Tjimanggoe, S. Bantam, Java.* Netherlands Indies, Dienst Mijnb., Wetensch. Meded., no 19, pp. 3–194.

1936 – *Zur Kenntnis der Miogypsiniden; I–II.* Ingenieur Nederl.-Indië, vol. 3, pp. 45–61, 84–98, 109–123.

1937*a* *Note on Miogypsina kotoi Hanzawa.* Ibid., vol. 4, pp. 31–32.

1937*b* *Weitere Untersuchungen über die Miogypsiniden; I–II.* Ibid., vol. 4, pp. 35–45, 87–111.

THALMANN, H. E.
1932 – *Das Vorkommen der Gattung Miogypsina Sacco* 1893 *in Ost-Mexico.* Eclogae Geol. Helv., vol. 25, pp. 282–286.

1947 – *Miogypsina-Vorkommen in West-Ecuador.* Ibid., vol. 39 (1946), no. 2, pp. 312–314.

TOBLER, A.
1926 – *Miogypsina im untersten Neogen von Trinidad und Borneo.* Eclogae Geol. Helv., vol. 19, pp. 719–722.

1927 – *Verkalkung der Lateralkammern bei Miogypsina.* Ibid., vol. 20, pp. 323–330.

VAUGHAN, T. W.
1924*a* *Criteria and status of correlation and classification of Tertiary deposits.* Geol. Soc. Amer., Bull., vol. 35, pp. 677–742.

1924*b* *American and European Tertiary larger foraminifera.* Ibid., vol. 35, pp. 785–822.

1926 – *Results of recent investigations of American Tertiary larger foraminifera.* Pan-Pacific Sci. Congr., 3rd, Proc., art. 72, pp. 1850–1857.

1928 – *Species of larger arenaceous and orbitoidal foraminifera from the Tertiary deposits of Jamaica.* Jour. Pal., vol. 1, no. 4, pp. 278–298.

VAUGHAN, T. W., AND COLE, W. S.
1941 – *Preliminary report on the Cretaceous and Tertiary larger foraminifera of Trinidad, British West Indies.* Geol. Soc. Amer., Spec. Papers, no. 30, pp. 1–85, 88–137.

1948 – *Family Miogypsinidae.* In: CUSHMAN, J. A., *Foraminifera, their classification and economic use.* Ed. 4. Cambridge, Mass.: Harvard University Press, pp. 347–367.

VLERK, I. M. VAN DER
1924 – *Miogypsina dehaarti nov. spec. de Larat (Moluques).* Eclogae Geol. Helv., vol. 18, pp. 429–432.

YABE, H., AND HANZAWA, S.
1928 – *Tertiary foraminiferous rocks of Taiwan (Formosa).* Imp. Acad. Japan, Proc., vol. 4, no. 6, pp. 532–536.

1929 – *Tertiary foraminiferous rocks of the Philippines.* Tohoku Imp. Univ., Sci. Repts., ser. 2 (Geol.), vol. 11 (1927–1929), no. 3, pp. 137–190.

1930 – *Tertiary foraminiferous rocks of Taiwan (Formosa).* Tohoku Imp. Univ., Sci. Repts., ser. 2 (Geol.), vol. 14, no. 1, pp. 1–46.

ABSTRACT: *Sixty-two species of Ostracoda have been recorded from the Brasso formation of central Trinidad. One genus, ten species, and one subspecies are described as new. The upper part of the Brasso formation is tentatively correlated with beds of the Choctawhatchee stage in Florida.*

Ostracoda of the Brasso formation of Trinidad

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INTRODUCTION

The Brasso formation represents the neritic facies of the upper part of the Cipero formation; it overlies the Nariva formation, with which its lower part interfingers, and unconformably underlies the Los Atajos conglomerate. Its area of outcrop in the Central Range and on the south flank of the Northern Basin has been sketched on the map (text-fig. 1), which has been adapted from Suter (1954). Lithologically, the Brasso formation consists of bluish-black shales and silts with intercalated limestones, sands and conglomerates. Its microfauna consists mainly of benthonic foraminifera. Pelagic foraminifera enable correlation to be made with the biostratigraphic zones of the Cipero formation, and the *Globorotalia fohsi*, *Globigerinatella insueta*, and *Globigerina dissimilis* zones have been recognized (Bolli, 1950). However, a number of samples are devoid of pelagic foraminifera, and this fact, coupled with the strongly disturbed position of the beds, makes internal correlation within the Brasso formation difficult.

Renz (1942, p. 554) subdivided the Brasso formation into four members, the upper one of which, the Los Atajos member, has since been separated from the Brasso formation and is nowadays considered to belong to the Manzanilla formation. The remaining members, from top to bottom, are the Navarro River member, the Tunnel Hill member, and the Esmeralda member. In 1948, Renz indicated his age determinations of these members as follows:

> Esmeralda: Rupelian, Chattian and lower Aquitanian.
> Tunnel Hill: Upper Aquitanian and lower Burdigalian.
> Navarro River: Upper Burdigalian and lower Helvetian.

These three members are lithologically not distinguishable in the field, and are based mainly on the distribution of benthonic foraminifera. As such, they are either biostratigraphic or biofacies zones and should not have member status. Studies of the pelagic foraminifera of the auger lines of K. Rohr (Texaco Trinidad, Inc.) by J. Stolk (Shell Trinidad Ltd.) and H. Bolli (Texaco Trinidad) show (private reports) that the Navarro River "member" and the Tunnel Hill "member" are in part contemporaneous and include beds of the *Globorotalia fohsi robusta*, *fohsi lobata*, *fohsi fohsi* and *fohsi barisanensis* zones and the *Globigerinatella insueta* zone. The Esmeralda member is, for the greater part, of *Globigerinatella insueta* zone age, but parts of it are slightly younger or older (see text-fig. 2). The names Esmeralda, Tunnel Hill and Navarro River are so familiar to students of Trinidad geology that it seems advisable to retain the names in this paper, at the same time keeping in mind that they are not members in the strict sense of the word.

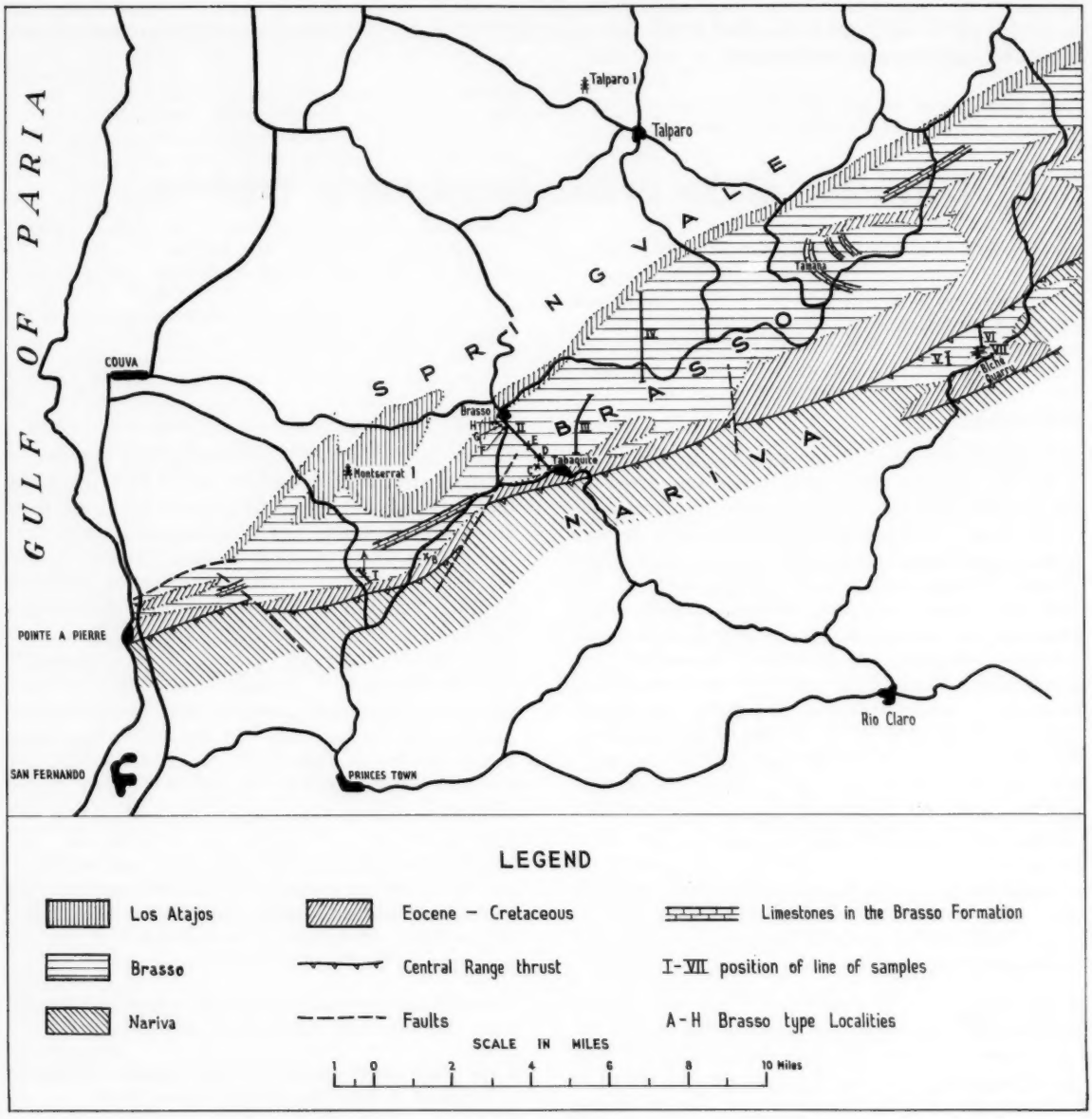
The Ostracoda described in this paper are mainly from the following sequences of samples:

Esmeralda auger line of K. Rohr (Texaco Trinidad) (text-fig. 1, line I).

Tabaquite auger line of K. Rohr, supplemented by surface samples collected by the same geologist (text-fig. 1, line II).

Basin Hill Reserve auger line of K. Rohr (text-fig. 1, line III).

Auger line of A. E. Gunther (Shell Trinidad) on the western boundary of the Central Range Forest Reserve, supplemented by surface samples collected by the same geologist (text-fig. 1, line IV).



TEXT-FIGURE 1
GEOLOGICAL SKETCH MAP OF CENTRAL TRINIDAD (after Suter, 1954)

Surface samples of A. E. Gunther, 1⅓ mile west of Biche Quarry (text-fig. 1, line V).

Auger samples of A. E. Gunther, ¾ to ½ mile due north of Biche Quarry (text-fig. 1, line VI).

Surface samples of A. G. Hutchison (Shell Trinidad) in Biche Quarry (text-fig. 1, line VII) (see also Hutchison and Terpstra, 1939).

Other samples studied have been collected by K. Rohr, H. G. Kugler, P. Bronnimann, A. E. Gunther, and others, but are so widely scattered that it is impractical to indicate their position on the map. The ostracode faunas of some of them are mentioned in the systematic descriptions. Ostracoda encountered in two wells of Trinidad Northern Areas (T.N.A.), Talparo no. 1 and Montserrat no. 1, have

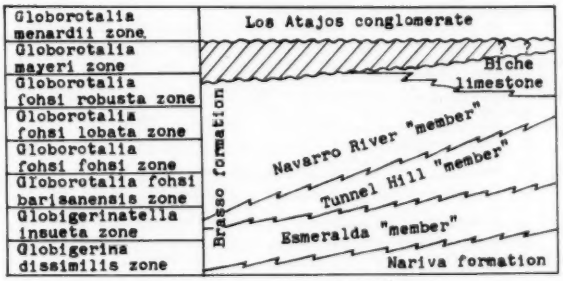
also been taken into account in the construction of the range chart (Table 1).

Of most samples, both the biostratigraphic zone and the "member" to which they belong are known. There are, however, a number of samples in which no or insufficient pelagic foraminifera were present. Many samples have been determined as belonging to the *Globorotalia fohsi sensu lato* zone. The range of the species found in such samples is indicated by a dotted line running throughout the *Globorotalia fohsi* subzones in Table 1.

All samples belong either to the collections of Texaco Trinidad, Inc., or to those of Shell Trinidad Ltd., and the managements of both these companies have kindly permitted the results of this study to be published, for which the writer expresses his sincere gratitude. Special mention should be made of the generous assistance of H. Bolli; the stratigraphic sequence used in Table 1 is based on his redeterminations of the pelagic foraminifera.

A number of species from the Brasso formation that were mentioned in a previous paper on the Oligo-Miocene Ostracoda (van den Bold, 1957*b*) are not included in the systematic descriptions because nothing new can be added.

Type specimens of the new species have been deposited in the collections of the United States National Museum in Washington.



TEXT-FIGURE 2

DESCRIPTION OF TYPE LOCALITIES

(See Renz, 1948.)

BRASSO FORMATION

Esmeralda calcareous clay "member"

A. Esmeralda "member," "lower zone":

Type locality: On trace across Esmeralda estate, 100 feet southeast from junction with Corosal Road, near 4¾ mile-post. Coordinates (Trinidad Government Cadastral): N-272,200; E-412,510 links.

Sample: Rohr 11876 (see text-fig. 1, line I, loc. A).

Lithology: Dark gray, yellowish-weathering, highly calcareous clay.

Stratigraphic determination: *Globigerinatella insueta* zone.

Ostracode fauna: *Cytherella polita* Brady, *Cytherella* aff. *sylverinica* Howe and Law, *Argilloecia hiwanneensis* Howe and Lea, *Bairdia bradyi* van den Bold, *Bairdia cespedecensis* van den Bold, *Bairdia exoura* van den Bold, *Krithe* aff. *producta* Brady, *Krithe reversa* van den Bold, n. sp., *Krithe hiwanneensis* Howe and Lea, *Bradleya dictyon* (Brady), *Echinocythereis asperrima* (Reuss).

B. Esmeralda "member," "upper zone":

Type locality: Guaracara River, east of Morichal, southeast of bridge B.2 on Guaracara-Tabaquite road near 10¼ mile-post. Coordinates: N-278,100; E-421,000 links (see text-fig. 1, loc. B).

Sample: Rohr 11637.

Lithology: Dark gray calcareous silty clay.

Stratigraphic determination: *Globigerinatella insueta* zone.

Ostracode fauna: *Argilloecia hiwanneensis* Howe and Lea, *Cytherella* aff. *sylverinica* Howe and Law, *Cytherella polita* Brady, *Propontocypris* sp., *Bradleya dictyon* (Brady), *Costa santacrucensis* van den Bold, *Trachyleberis reticulospinosa* (van den Bold), *Ambocythere? sulcata* van den Bold, *Cytheropteron renzi* van den Bold.

Tunnel Hill silty clay "member"

C. Tunnel Hill "member," "lower zone":

Type locality: Tabaquite River east, 650–900 feet north of Diaz trace. Coordinates: N-295,600 to 295,930 links; E-442,820 to 443,000 links (text-fig. 1, line II, loc. C).

Sample: Rohr 4716, 4718.

Lithology: Dark gray calcareous silty clay.

Stratigraphic determination: Upper part of *Globigerinatella insueta* zone or basal *Globorotalia fohsi barisanensis* zone.

Ostracode fauna: *Cytherella polita* Brady, *Cytherella* sp., *Perissocytheridea reticulata* (van den Bold), *Bradleya dictyon* (Brady), *Trachyleberis reticulospinosa* (van den Bold), *Costa variabilocostata* (van den Bold), *Costa santacrucensis* van den Bold, *Cativella* aff. *semitranslucens* (Crouch), *Loxoconcha banesensis* van den Bold, *Xestoleberis* aff. *glabrescens* (Reuss).

D. Tunnel Hill "member," "upper zone":

Type locality: Tabaquite River east, about 500 feet southeast of Long Hill trigonometric station. Co-

ordinates: N-297,680 to 297,930 links; E-442,080 to 442,500 links (see text-fig. 1, line II, loc. D).

Sample: Rohr 4721A, 4722A.

Lithology: Dark gray calcareous silty clay.

Stratigraphic determination: *Globigerinatella insueta* zone.

Ostracode fauna (also included is the fauna of Rohr sample 4719): *Cytherella* sp., *Perissocytheridea reticulata* (van den Bold), *Munseyella punctata* van den Bold, n. sp., *Ambocythere? sulcata* van den Bold, *Trachyleberis reticulospinosa* (van den Bold), *Costa variabilocostata* (van den Bold), *Costa variabilocostata seminuda* van den Bold, n. subsp., *Costa santacrucensis* van den Bold, *Cativella* aff. *semitranslucens* (Crouch), *Orionina bermudae* (Brady)?, *Basslerites minutus* van den Bold, n. sp., *Loxoconcha banesensis* van den Bold, *Loxoconcha? rohri* van den Bold, n. sp., *Eucytherura? ruggierii* van den Bold, n. sp., *Cytheropteron renzi* van den Bold, *Cytheropteron* sp.

Navarro River clay "member"

E. Navarro River "member," "lower zone":

Type locality: Jubilee estate, near Fernando's house, south of Caparo River and north of Tabaquite trace. Coordinates: N-300,650; E-439,600 links (see text-fig. 1, line II, loc. E).

Sample: Rohr 12339A.

Lithology: Dark gray calcareous clay.

Stratigraphic determination: *Globigerinatella insueta* zone.

Ostracode fauna: *Cytherella polita* Brady, *Cytherella* sp., *Trachyleberis reticulospinosa* (van den Bold), *Costa variabilocostata* (van den Bold), *Costa variabilocostata seminuda* van den Bold, n. subsp., *Costa santacrucensis* van den Bold, *Cativella* aff. *semitranslucens* (Crouch), *Xestoleberis* aff. *glabrescens* (Reuss).

F. Navarro River "member," "middle zone":

Type locality: Navarro River, about 200 feet southwest of junction with Caparo River, near Caparo Valley road bridge, north of $12\frac{3}{4}$ mile-post. Coordinates: N-304,850; E-437,380 links (see text-fig. 1, line II, loc. F).

Sample: Rohr 281.

Lithology: Dark gray calcareous clay.

Stratigraphic determination: *Globorotalia fohsi fohsi* zone.

Ostracode fauna: *Cytherella polita* Brady, *Costa variabilocostata* (van den Bold), *Cativella* aff. *semitranslucens* (Crouch), *Orionina bermudae* (Brady)?.

G. Navarro River "member," "repetition zone":

Type locality: Caparo River, near Caparo Valley road, about 1350 feet southeast of Brasso-Tamana road junction. Coordinates: N-305,660; E-436,400 links (see text-fig. 1, line II, loc. G).

Sample: Rohr 33.

Lithology: Dark gray calcareous clay.

Stratigraphic determination: *Globorotalia fohsi lobata* zone.

Ostracode fauna: *Cytherella polita* Brady, *Cytherella* aff. *pulchra* Brady, *Macrocypris decora* (Brady), *Krithe* aff. *producta* Brady, *Costa santacrucensis* van den Bold, *Cativella* aff. *semitranslucens* (Crouch), *Cativella navis* Coryell and Fields, *Basslerites minutus* van den Bold, n. sp., *Cytheropteron renzi* van den Bold, *Cytheropteron subreticulatum* van den Bold.

H. Navarro River "member," "upper zone":

Type locality: Caparo River, Brasso village, near junction of Brasso-Tamana road and Caparo Valley road. Coordinates: N-307,270; E-435,280 links (see text-fig. 1, line II, loc. H).

Sample: Rohr 21.

Lithology: Dark gray calcareous clay with abundant mollusks.

Stratigraphic determination: *Globorotalia fohsi sensu lato* zone. Probably uppermost part.

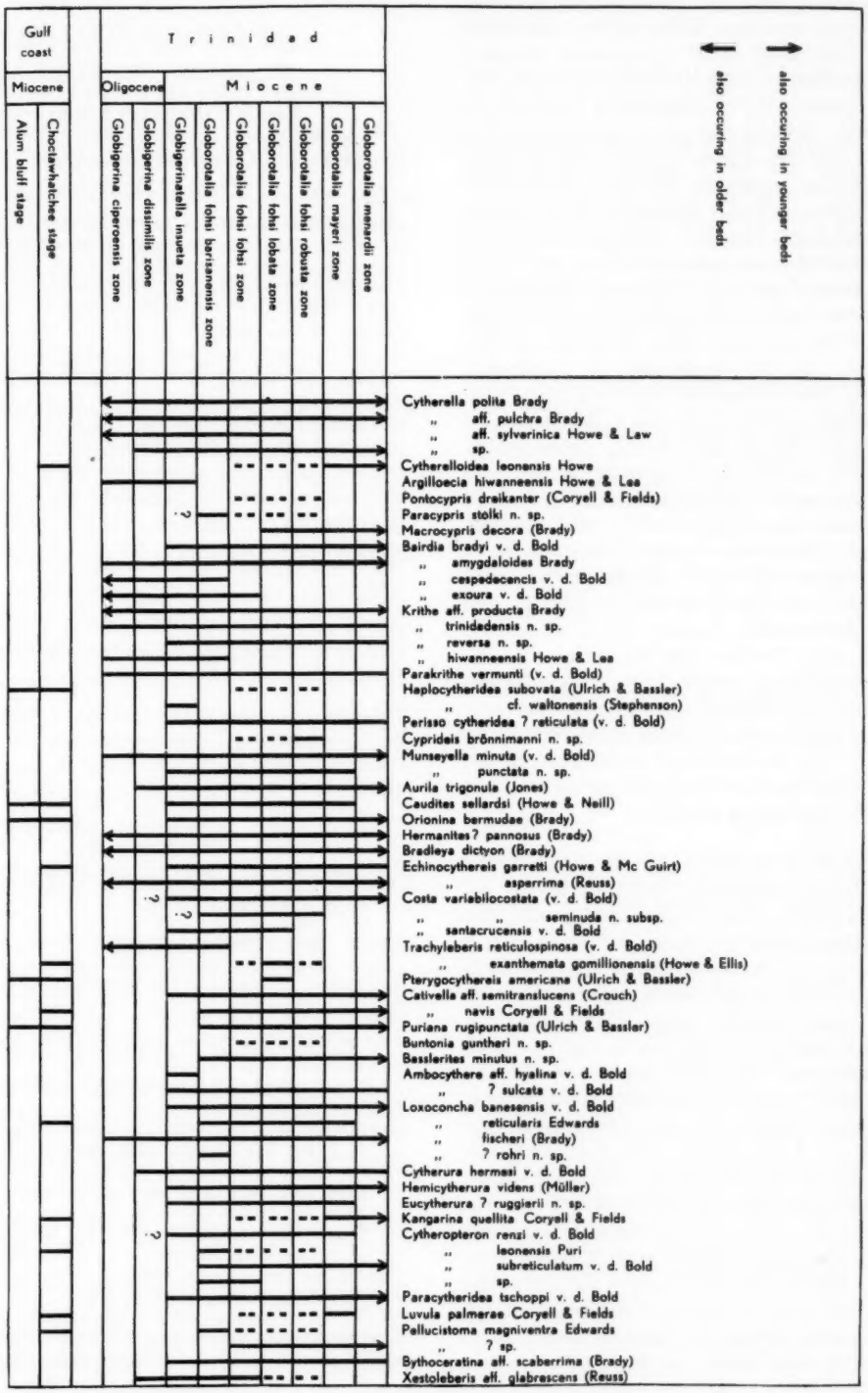
Ostracode fauna: *Cytherella polita* Brady, *Cytherella* aff. *pulchra* Brady, *Macrocypris decora* (Brady), *Bairdia bradyi* van den Bold, *Perissocytheridea reticulata* (van den Bold), *Cyprideis bronnimanni* van den Bold, n. sp., *Munseyella punctata* van den Bold, n. sp., *Costa variabilocostata* (van den Bold), *Cativella navis* Coryell and Fields, *Orionina bermudae* (Brady)?, *Puriana rugipunctata* (Ulrich and Bassler), *Basslerites minutus* van den Bold n. sp., *Loxoconcha banesensis* van den Bold, *Loxoconcha reticularis* Edwards, *Hemicytherura videns* (Müller), *Kangarina quellita* Coryell and Fields, *Cytheropteron leonensis* Puri, *Luvula palmerae* Coryell and Fields.

DISCUSSION OF OSTRACODE FAUNA

The following species occur only in beds younger than what could be definitely established as the *Globigerinatella insueta* zone:

Cytherelloidea leonensis Howe, *Pontocypris dreikanter* (Coryell and Fields), *Paracypris stolki* van den Bold, n. sp., *Macrocypris decora* (Brady), *Haplocytheridea subovata* (Ulrich and Bassler), *Cyprideis bronnimanni* van den Bold, n. sp., *Trachyleberis exanthemata gomillionensis* (Howe and Ellis), *Pterygocythereis americana* (Ul-

TABLE 1
RANGE CHART OF OSTRACODA OF THE BRASSO FORMATION



rich and Bassler), *Cativella navis* (Coryell and Fields), *Costa variabilocostata seminuda* van den Bold, n. subsp., *Puriana rugipunctata* (Ulrich and Bassler), *Buntonia guntheri* van den Bold, n. sp., *Basslerites minutus* van den Bold, n. sp., *Loxoconcha reticularis* Edwards, *Loxoconcha? rohri* van den Bold, n. sp., *Cytheropteron leonensis* Puri, *Cytheropteron subreticulatum* van den Bold, *Cytheropteron* sp., *Kangarina quellita* Coryell and Fields, *Luvula palmerae* Coryell and Fields, *Pellucistoma magniventra* Edwards, and *Pellucistoma?* sp. Eleven of these species have previously been recorded from Florida; eight of them have not been recorded from beds older than the Choctawhatchee stage. Species which have their lowermost occurrence in the *Globigerinatella insueta* zone are: *Bairdia bradyi* van den Bold, *Krithe reversa* van den Bold, n. sp., *Haplocytheridea* cf. *waltonensis* (Stephenson), *Perissocytheridea? reticulata* (van den Bold), *Munseyella punctata* van den Bold, n. sp., *Caudites sellardsi* (Howe and Neill), *Orionina bermudae* (Brady)?, *Echinocythereis garretti* (Howe and McGuirt), *Ambocythere? sulcata* van den Bold, *Costa santacrucensis* van den Bold, *Cativella* aff. *semitranslucens* (Crouch), *Loxoconcha banesensis* van den Bold, *Hemicytherura videns* (Müller), *Eucytherura? ruggierii* van den Bold, n. sp., *Paracytheridea tschoppi* van den Bold, and *Bythoceratina scaberrima* (Brady). Of these species, only *Caudites sellardsi*, *Orionina bermudae*, and *Echinocythereis garretti* have been recorded from the American Miocene, but, as can be seen from Table 1, their vertical ranges are different; the second species has its lowermost occurrence in the Alum Bluff stage, but the other two are known only from the Choctawhatchee stage.

It would appear from these data that the upper part of the Brasso formation (the beds above the *Globigerinatella insueta* zone) is correlatable with the beds of the Choctawhatchee stage in Florida. However, according to Akers (1955), *Globigerinatella insueta* occurs in beds equivalent to those below the top of the (older) Tampa stage. *Globorotalia fohsi fohsi* and *Globorotalia fohsi barisanensis* occur in beds which, according to Puri (1953*c*), correlate with the basal Alum Bluff stage. It appears, therefore, that *Orionina bermudae* (Brady), for example, appeared in South America at an earlier time than in North America (see also van den Bold, 1957*b*, p. 233), and that the upper part of the Brasso formation should be considered about equivalent to the Alum Bluff stage (based on the distribution of *Haplocytheridea subovata*, *Puriana rugipunctata* and *Pterygocythereis americana*). Until more is known of the lower ranges of these Ostracoda (from the Tampa stage), however, no reliable conclusions can be drawn.

SYSTEMATIC DESCRIPTIONS

Order OSTRACODA

Suborder PLATYCOPA

Family CYTHERELLIDAE

Genus CYTHERELLA Jones, 1849

Cytherella aff. **Cytherella sylverinica** Howe and Law
Plate 1, figure 1a–b

Cytherella sylverinica HOWE AND LAW, 1936, Louisiana, Dept. Cons., Geol. Bull. no. 7, p. 18, pl. 1, figs. 12–13.

Carapace ovate, highest just behind the middle. Anterior end evenly rounded, in left valve with a thin carina; dorsal margin convex in right valve, nearly straight in anterior part, slightly convex behind the middle and sloping down toward the posterior end; ventral margin slightly convex in both valves; posterior end almost evenly rounded, more narrowly than anterior end. Right valve overlapping the left along dorsal and ventral margins, overlapping less at the ends. Dorsal view wedge-shaped, widest one-fourth of the length from the posterior end, which is rather regularly rounded.

Dimensions: Length 0.98 mm.; height 0.51 mm.; width 0.38 mm.

Dorsal view identical with *Cytherella sylverinica*. In side view, however, the position of greatest height is slightly more posterior.

This species occurs in the Esmeralda "member" of the Brasso formation (*Globigerinatella insueta* zone) and in the *Globorotalia fohsi lobata* zone in T.N.A.'s well Montserrat no. 1.

Cytherella sp.

Cytherella sp., VAN DEN BOLD, 1957, Micropaleontology, vol. 3, no. 3, p. 235, pl. 1, fig. 3.

Range: Upper Oligocene to Pliocene.

Occurrence: Throughout the Brasso formation.

Genus CYTHERELLOIDEA Alexander, 1929

Cytherelloidea leonensis Howe

Cytherelloidea leonensis HOWE, 1934, Jour. Pal., vol. 8, p. 34, pl. 5, fig. 9. – CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 2, text-fig. 1a–c. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 62, pl. 9, fig. 23. – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 80. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 301, pl. 17, fig. 3; text-fig. 14c.
Cytherelloidea purii SEXTON, 1951, Jour. Pal., vol. 25, p. 815, pl. 117, fig. 16 (*fide* Puri, 1953*c*).

This species appears to occur from the *Globorotalia fohsi* zone upward, and has also been found in the Pliocene.

Family CYPRIDIDAE

Subfamily PONTOCYPRIDINAE

Genus ARGILLOECIA Sars, 1866

Argilloecia hiwanneensis Howe and Lea

Argilloecia hiwanneensis Howe and Lea. – VAN DEN BOLD, 1957, Micropaleontology, vol. 3, no. 3, p. 235.

This species has been found only in the Esmeralda "member." So far it has not been found in beds younger than the *Globigerinatella insueta* zone. This species has been erroneously recorded from the Lengua formation (Middle Miocene) (van den Bold, 1957*b*, Table 1).

Genus PONTOCYPRIS Sars, 1866

Pontocypris dreikanter (Coryell and Fields)
Plate 2, figure 2a–b

Macrocypris dreikanter CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 3, text-fig. 3.
Erythrocypris dreikanter (Coryell and Fields). – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 63, pl. 3, fig. 3.

Dimensions: Length 0.63 mm.; height 0.31 mm.; width 0.22 mm.

In the Brasso formation this species appears to be confined to the Navarro River "member" (*Globorotalia fohsi sensu lato* zone).

Subfamily CANDONINAE

Genus PARACYPRIS Sars, 1866

Paracypris stolki van den Bold, **new species**
Plate 2, figure 1a–b

Carapace elongate triangular, highest in front of the middle. Anterior end low, evenly rounded; dorsal margin angled at the greatest height and very obtusely angled in the middle of the posterior slope; anterior part nearly straight, middle part convex, posterior part straight or even slightly concave; ventral margin concave in the middle; posterior end acuminate, low. Left valve overlapping the right along the dorsal margin and in the middle of the ventral margin. Dorsal view narrow, greatest width just in front of the middle, anterior end compressed.

Dimensions: Length 0.66 mm.; height 0.29 mm.; width 0.27 mm.

This species differs from *Paracypris rosefieldensis* Howe and Law (1936, p. 30, pl. 3, figs. 9–11) in dorsal view in the compressed anterior end, and in side view in details of the shape of the dorsal margin; the anterior end is comparatively higher. The species has been named in honour of Mr. J. Stolk, assistant palaeontologist with Shell Trinidad Ltd. It occurs in the upper Tunnel Hill and Navarro River "members."

Holotype: A complete carapace from Rohr sample 4866, U. S. Nat. Mus. no. 562068.

Rohr sample 4866 is from an outcrop on the Caparo River south of Brasso village. This sample was determined by Bolli as belonging to the upper part of the *Globigerinatella insueta* zone or to the basal *Globorotalia fohsi barisanensis* zone (personal communication, April, 1957). An earlier determination by Bolli (*fide* Kugler, letter dated April 3, 1956) as the *Globorotalia fohsi sensu lato* zone appears to be more in accordance with the distribution of the Ostracoda:

Cytherella polita Brady, *Cytherella* aff. *pulchra* Brady, *Paracypris stolki* van den Bold, n. sp., *Krithe* aff. *producta* Brady, *Perissocytheridea reticulata* (van den Bold), *Costa variabilocostata* (van den Bold), *Costa variabilocostata seminuda* van den Bold, n. subsp., *Cativella* aff. *semitranslucens* (Crouch), *Puriana rugipunctata* (Ulrich and Bassler), *Orionina bermudae* (Brady)?, *Basslerites minutus* van den Bold, n. sp., *Loxoconcha banesensis* van den Bold, *Loxoconcha reticularis* Edwards, *Cytheropteron subreticulatum* van den Bold, and *Pellucistoma magniventra* Edwards.

Family MACROCYPRIDIDAE

Genus MACROCYPRIS Brady, 1867

Macrocypris decora (Brady)
Plate 1, figure 2

Cytherideis decora BRADY, 1866, Zool. Soc. London, Trans., vol. 5, p. 366, pl. 57, fig. 13a–c.
Paracypris hieroglyphica BRADY, 1868, *Fonds de la mer*, vol. 1, p. 62, pl. 7, figs. 7–8.
Paracypris decora (Brady). – BRADY, 1868, Linnean Soc. London, Trans., vol. 26, p. 335.
Macrocypris decora (Brady). – BRADY, 1880, Rept. Voy. Challenger, Zool., vol. 1, p. 44, pl. 1, fig. 3; pl. 6, fig. 8. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 65, pl. 1, fig. 14. – VAN DEN BOLD, 1950, Ann. Mag. Nat. Hist., ser. 12, vol. 3, p. 901. – KEY, 1954, K. Nederl. Akad. Wetensch., Verh., ser. 1, vol. 20, p. 219, pl. 3, fig. 10; pl. 6, fig. 4.
?*Macrocypris decora* (Brady). – CHAPMAN, 1906, Roy. Soc. Victoria, Proc., p. 6. – CHAPMAN, 1916, Victoria, Geol. Survey, Rec., vol. 3, pp. 379, 389, pl. 72, fig. 2. – CHAPMAN AND CRESPIN, 1928, Victoria, Geol. Survey, Rec., vol. 5, p. 168.

Range in Trinidad: From the *Globorotalia fohsi sensu lato* zone to the Recent.

Occurrence: Navarro River "member" of the Brasso formation.

Family CYTHERIDAE

Subfamily CYTHERIDEINAE

Genus KRITHE Brady, Crosskey and Robertson, 1874

Krithe aff. **Krithe producta** Brady
Plate 2, figure 3a–f

?Krithe producta BRADY, 1880 (part), Rept. Voy. Challenger, Zool., vol. 1, p. 114, pl. 27, fig. 1a–d (not fig. 1e–j).
?Krithe producta Brady. – KEY, 1954 (part), K. Nederl. Akad. Wetensch., Verh., ser. 2, vol. 20, p. 220, pl. 4, fig. 3; pl. 6, fig. 3b (not fig. 3a).

Female: Carapace ovate, highest behind the middle, widest just behind the middle. Anterior end evenly rounded; dorsal margin arched in the left valve, sinuate with anterior depression in the right valve; ventral margin convex; posterior end obliquely truncate, narrowly rounded below. The posterior margin is more steeply truncate than the outline of the valves, which projects beyond it. Posterior end incised in dorsal view. Left valve overlapping the right along the dorsal margin, overlap strongest in anterior part.

Male: Carapace elongate, highest in the middle, widest in the middle. Anterior end evenly rounded; dorsal margin convex with flattened central part in the left valve, sinuate in the right valve; ventral margin nearly straight; posterior end in the left valve obliquely curved, acutely angled below; in the right valve the posterior outline is a continuation of the dorsal margin, which curves downward toward the posteroventral angle. Posterior end deeply incised in dorsal view.

Duplicature in the anterior end broad; line of concrescence forms a loop toward the outer margin; the vestibule has quite a narrow connection with the interior of the valve. Number of pore canals in the anterior part of the loop eleven or twelve. Muscle scars: A posterior row of four, of which the upper one is U-shaped, with one big clover-leaf-shaped scar in front.

Dimensions:

Female: Length 0.68 mm.; height 0.41 mm.; width 0.39 mm.

Male: Length 0.76 mm.; height 0.39 mm.; width 0.34 mm.

The female of this species is very close to *Krithe producta* as figured by Brady (1880, pl. 27, fig. 1a–d). Figures 1e–j are so different from the first four that they should be considered as belonging to different species. However, in the Challenger figures the right valve is larger than the left and overlaps it in much the same way as the left valve overlaps the right in the Trinidad specimens. *Krithe cubensis* van den Bold (1946, p. 75, pl. 4, fig. 13) is slightly more elongate and does not show the pronounced overlap of the left valve in the anterior part of the dorsal margin.

The male is different from any of the figured Challenger specimens and in fact so different from the female that at first it was considered to be a separate species. However, the characteristic muscle scar and the constant shape of the anterior marginal area in both male and female caused them to be regarded as one species. The male is rather similar in outline to the male of *Krithe guatemalensis* van den Bold (1957*a*, p. 7, pl. 1, fig. 5a–e), which may possibly have been an ancestor.

The species occurs in the Esmeralda and Navarro River "members" of the Brasso formation but is much more common in the Cipero and Lengua formations, and its range has been provisionally established in Trinidad as Oligocene to Pliocene. As the marginal area of the Eocene forms could not be studied owing to recrystallization, it is possible that the two forms are not identical. The *Krithe producta* Brady recorded by Key (1954) from the seas around Trinidad may be the same species as the fossil one.

Typical specimens have been deposited in the collections of the U. S. National Museum, no. 562060.

Krithe trinidadensis van den Bold, **new species**
Plate 1, figure 3a–g

Female: Carapace ovate, highest and widest in the middle. Anterior end regularly rounded; dorsal and ventral margin gently convex and subparallel; posterior end obliquely truncate, narrowly rounded below, projecting beyond the posterior margin, which is almost vertically truncate. Left valve overlapping the right along dorsal and ventral margins, overlap strongest at anterodorsal margin.

Male: Carapace elongate, highest near anterior end, widest in front of the middle. Anterior end regularly rounded; dorsal and ventral margins nearly straight and converging very gently posteriorly; posterior end obliquely truncate, almost acutely angled below. Overlap similar to that of the female. Marginal area with complicated loop of line of concrescence in anterior end; vestibule connected with the interior of the valves by a narrow channel only. Pore canals nine or ten in anterior part of the loop, which has a characteristic indentation in the middle. Muscle scars four in a vertical row, the top one kidney-shaped; in front two scars, the upper one of which is V-shaped.

Dimensions:

Female: Length 1.00 mm.; height 0.59 mm.; width 0.52 mm.

Male: Length 0.93 mm.; height 0.45 mm.; width 0.36 mm.

The species occurs in the Esmeralda and Navarro River "members" of the Brasso formation. It is much more common in the Cipero and Lengua formations, and the range has been established as from the *Globigerina ciperoensis* zone (Oligocene) of the Cipero formation up to the lower part of the Cruse formation (Middle Miocene).

Holotype: A left valve of a female from Favre sample 56a, Cipero formation *(Globorotalia fohsi lobata* zone), 4.2 miles east of Rio Claro, just south of the Naparima-Mayaro road. U. S. Nat. Mus. no. 562059.

Krithe reversa van den Bold, **new species**
Plate 1, figure 4a–g

Carapace very similar to the preceding species in both male and female, but the marginal area is much simpler, and the species is distinguished by reversal of valve overlap and size.

Female: Carapace ovate, highest just in front of the middle, widest just behind the middle. Anterior end regularly rounded; dorsal margin gently convex in the right valve, slightly sinuate with anterior depression in the left; ventral margin nearly straight and subparallel to the dorsal; posterior margin nearly vertically truncate, with the outline of the valves projecting beyond it. Right valve larger than the left and overlapping it both dorsally and ventrally; overlap strongest in the anterior part of the dorsal margin.

Male: Carapace elongate, highest near anterior end, widest just in front of the middle. Anterior end regularly rounded; dorsal margin straight, ventral margin slightly sinuate, converging gently posteriorly; posterior end acutely angled below, projecting beyond the obliquely truncate posterior margin. Marginal area simple for the genus, with only a small loop of the line of concrescence in the anterior end, with about ten radial pore canals and a few false radial ones. In the male the loop is slightly larger than in the female and somewhat upwardly deflected. Hinge consists of a slightly sinuate groove in the dorsal margin of the right valve, into which the dorsal margin of the left valve fits; the latter shows some minute crenulations. Muscle scars four in a vertical row, with one V-shaped scar in front.

Dimensions:

Female: Length 1.04 mm.; height 0.56 mm.; width 0.48 mm.

Male: Length 1.09 mm.; height 0.52 mm.; width 0.39 mm.

In the Brasso formation, this species has been found only in the Esmeralda "member." It is more common in the Cipero and Lengua formations, where the range has been established as from the *Globigerinatella insueta* zone up to the *Globorotalia menardii* zone.

Holotype: A right valve of a female carapace from Favre sample 56a, Cipero formation *(Globorotalia fohsi lobata* zone), 4.2 miles east of Rio Claro, just south of the Naparima-Mayaro road. U. S. Nat. Mus. no. 562061.

Genus **Parakrithe** van den Bold, **new genus**

Type species: Cytheridea (Dolocytheridea) vermunti van den Bold, 1946.

Carapace small, subrectangular. Anterior end rounded, posterior end obliquely truncate, narrowly rounded below; dorsal and ventral margins nearly straight and subparallel; the ventral margin usually has a sharp concavity just in front of the middle. Left valve usually overlapping the right along dorsal and posterior margins. Reversal of overlap and valve sizes may occur.

Marginal area broad in the anterior end, crossed by a small number (ten in the type species) of long radial pore canals, from which shorter false radial ones sometimes split off (six or seven in the type species). Line of concrescence and inner margin coincide except in the anterior end. Hinge consists of a groove in the dorsal margin of the larger (usually the left) valve, into which a bar below the dorsal margin of the smaller valve fits; the posterior parts of the bar and the groove are slightly crenulate. Muscle scars: Posterior vertical row of four, with three additional scars in front, the lower one of which is V-shaped. Normal pore canals few, open; eleven observed in the type species.

This genus differs from *Krithe* in the structure of the marginal area and in the muscle scars, as well as in lacking the posterior indentation that is usual in *Krithe.*

Observed range: Eocene to Recent.

Apart from the two species described here, the following Recent species appear to belong to this genus (listed in descending order of probability):

Krithe radiolata Egger, 1901, p. 451, pl. 7, figs. 32–33;
Cythere plana Brady, 1868*b*, p. 180, pl. 13, figs. 7–8;
Krithe angusta Brady and Norman, 1889 (part), p. 181, pl. 17, figs. 10–12 (not fig. 13);
Paradoxostoma reniformis Brady, 1868*c*, p. 224, pl. 15, fig. 1–2.

Parakrithe vermunti (van den Bold)
Plate 4, figure 7a–f

Cytheridea (Dolocytheridea) vermunti VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda,* p. 83, pl. 7, fig. 12a–c.

Female: Carapace subrectangular, highest and widest behind the middle. Anterior end evenly rounded; dorsal margin nearly straight, slightly convex; ventral margin sinuate, subparallel; posterior end very obliquely rounded, narrowly rounded below. Left valve overlapping the right along dorsal and posterior margins, only very slightly at the anterior end in the middle of the ventral margin.

Male: Elongate, subrectangular, widest behind the middle. Anterior end evenly rounded; dorsal margin straight, ventral margin slightly sinuate, parallel; posterior end obliquely truncate, acutely angled below. Overlap same as in female. Marginal area broad in anterior end, radial pore canals ten, long, slender and slightly curved; a small number (six or seven) of false radial pore canals, which are much shorter. Hinge and muscle scars as described for the genus.

Dimensions:

Female: Length 0.59 mm.; height 0.27 mm.; width 0.22 mm.

Male: Length 0.61 mm.; height 0.27 mm.; width 0.21 mm.

The writer assigned this species originally to the subgenus *Dolocytheridea* of Triebel (1938) because of its resemblance to *Cytheridea (Dolocytheridea) bosqueti* (Jones and Hinde) (Triebel, 1938, pl. 6, fig. 91). The species is closely related to *Krithe radiolata* Egger (1901, p. 451, pl. 7, figs. 32–33) and, as pointed out by Kingma (1948, p. 51), may possibly be identical. However, the one valve from the Gazelle Expedition figured by Egger and the one from the Snellius Expedition figured by Kingma (1948, pl. 7, fig. 10) are more elongate. Length-height ratio in these two specimens is 1:0.41, whereas in the Caribbean specimens it varies from 1:0.44 to 1:0.46 in the male, and from 1:0.46 to 1:0.47 in the female.

Parakrithe vermunti has been found in the Esmeralda and Navarro River "members" of the Brasso formation. It occurs in slightly greater numbers in the Cipero and Lengua formations, and has also been found in the lower part of the Cruse formation.

Range: Lower Oligocene *(Globigerina ciperoensis* zone) to Middle Miocene (*Globorotalia menardii* zone).

Typical specimens have been deposited in the collections of the U. S. National Museum, no. 562063.

Parakrithe reversa van den Bold, **new species**
Plate 4, figure 9a–f

Very similar to the preceding species, but with reversal of valve sizes and overlap.

Female: Carapace subrectangular, highest and widest just behind the middle. Anterior end evenly rounded; dorsal margin nearly straight, very gently convex; ventral margin slightly concave, parallel; posterior end truncate, narrowly rounded, almost angled below. Right valve overlapping the left along dorsal margin and posterior end, very slightly along part of anterior and ventral margins.

Male: Carapace elongate subrectangular, widest in the middle. Anterior end regularly rounded; dorsal margin nearly straight, ventral margin very slightly concave, parallel; posterior end obliquely truncate, very narrowly rounded below. Overlap as in the female.

Marginal area broad in anterior end. Line of concrescence irregularly indented, with branching pore canals, ten to fifteen radial ones and a small number of false radial ones. Muscle scars: A posterior row of four, the top one of which is kidney-shaped, and three additional ones in front, the lower one of which is V-shaped. Hinge consists of a groove in the dorsal margin of the right valve, into which the dorsal edge of the left valve fits.

Dimensions:

Female: Length 0.58 mm.; height 0.29 mm.; width 0.24 mm.

Male: Length 0.60 mm.; height 0.28 mm.; width 0.22 mm.

This species has not been found in the Brasso formation, but is described here for comparison with the type species. It has been found only in the Lengua formation.

Holotype: A complete carapace from Favre sample 7026, *Globorotalia menardii* zone of the Lengua formation, 3 miles east of Rio Claro on the old Rio Claro-Mayaro road. U. S. Nat. Mus. no. 562062.

Genus HAPLOCYTHERIDEA Stephenson, 1936

Haplocytheridea subovata (Ulrich and Bassler)
Plate 3, figure 6a–f

Cytheridea subovata ULRICH AND BASSLER, 1904, Maryland Geol. Survey, Miocene, p. 124, pl. 37, figs. 1–8 (not *Cytheridea subovata* (von Münster) of Egger, 1858 = *Cytheropteron eggerianum* Lienenklaus, 1896).

?*Cytheridea subovata* Ulrich and Bassler. – DOEGLAS, 1931, Netherlands Indies, Dienst Mijnb., Wetensch. Meded., no. 17, p. 44.

Cytheridea (Haplocytheridea) subovata Ulrich and Bassler. – STEPHENSON, 1938, Jour. Pal., vol. 12, p. 134, pl. 23, fig. 23; pl. 24, figs. 9–10; text-fig. 3 (not *Cytheridea (Haplocytheridea) subovata* Sutton and Williams, 1939, Jour. Pal., vol. 13, p. 569, pl. 64, figs. 26–28 = *Haplocytheridea bastropensis* Sutton and Williams, 1940).

Haplocytheridea bassleri STEPHENSON, 1943, Jour. Pal., vol. 17, p. 206. – PURI, 1953, Jour. Pal., vol. 27, p. 751. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 230, pl. 3, figs. 1–4; text-fig. 4c–f. – SWAIN, 1955, Jour. Pal., vol. 29, p. 717, pl. 59, fig. 9a–b.

Cytheridea (Haplocytheridea) bassleri (Stephenson). – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 80, pl. 8, fig. 4.

Haplocytheridea subovata (Ulrich and Bassler). – SWAIN, 1951, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 22, pl. 1, figs. 19–20. – MALKIN, 1953, Jour. Pal., vol. 27, p. 782, pl. 79, figs. 15–16.

The synonymy of this species has been given in full as there is some confusion about the proper name of this species. Actually, the name given originally by Ulrich and Bassler is valid. In 1858, Egger described a species from the Bavarian Miocene which he thought was identical with *Cythere subovata* von Münster (1830); Egger called his form *Cytheridea subovata* (von Münster). Lienenklaus (1896), however, pointed out that the species was misidentified, and he redescribed it as *Cytheropteron eggerianum* Lienenklaus. *Cythere subovata* von Münster, according to Lienenklaus (1896, p. 198), belongs to the genus *Loxoconcha* and was redescribed by Egger (1858) under the name *Cytheridea clypeus* Egger.

Dimensions:

Female: Length 0.76 mm.; height 0.47 mm.; width 0.39 mm.

Male: Length 0.77 mm.; height 0.44 mm.; width 0.33 mm.

This species, which apparently has a range of Lower Miocene to Recent, has been found only in the upper part of the Navarro River "member" of the Brasso formation in Trinidad (*Globorotalia fohsi sensu lato* zone).

Genus CYPRIDEIS Jones, 1857

Cyprideis bronnimanni van den Bold, **new species**
Plate 2, figure 4a–f

Female: Carapace ovate, highest just in front of the middle. Anterior end evenly rounded, bearing a finely denticulate rim; dorsal margin in the left valve arched, the posterior slope curving down into the obliquely rounded posterior end; dorsal margin in the right valve bluntly angled at the greatest height, both anterior and posterior slopes nearly straight; posterior end narrowly rounded ventrally in the left valve, angled in the right and bearing a few short, stout spines; ventral margin convex in the left valve, sinuate in the right. Left valve overlapping the right along the entire periphery except the posteroventral corner, overlap strongest in the middle of both straight portions of the dorsal margin in the right valve, and in the posterior half of the ventral margin. Dorsal view short, thickset, widest behind the middle, slightly compressed just in front of the middle. Anterior rim projecting. Surface of the valves finely punctate. There is a very faint, vertical median sulcus just below the greatest height.

Male: Similar in general shape to the female, but greatest height more anterior, and consequently the posterior portion of the carapace is more slender, while the anterior end appears relatively higher. Greatest width in anterior half. Hinge and marginal area typical of the genus.

Dimensions:

Female: Length 0.65 mm.; height 0.39 mm.; width 0.31 mm.

Male: Length 0.62 mm.; height 0.36 mm.; width 0.28 mm.

This species is very close to *Cyprideis hungarica* Zalanyi (1944, p. 83, pl. 6, figs. 10–13; text-figs. 53–57), but differs in the shape of the posterior margin and in the denticulation of the anterior end, which in *Cyprideis hungarica* bears only a few, slightly larger spines.

The species has been named in honour of Dr. Paul Bronnimann. It has been found in the upper part of the Navarro River "member" of the Brasso (*Globorotalia fohsi sensu lato* zone), and in the *Globorotalia fohsi robusta* zone of the Karamat formation.

Holotype: A complete carapace of a female from Rohr sample 21, upper Navarro River "member" of the Brasso formation (*Globorotalia fohsi sensu lato* zone, probably the highest part) (see text-fig. 1, line II, loc. H). U. S. Nat. Mus. no. 562071.

Subfamily LEPTOCYTHERINAE

Genus **Perissocytheridea** Stephenson, 1938

?Ilyocythere KLIE, 1939, Zool. Jahrb., Abt. Syst., vol. 72, p. 364.

The shell characteristics of *Ilyocythere* Klie are very like those of *Perissocytheridea*. Recent specimens from Trinidad, determined on shell structure by the writer as *Perissocytheridea*, were identified on the basis of soft parts as *Ilyocythere* by Dr. G. Hartmann of Osnabrück (personal communication of November 18, 1957). As *Ilyocythere* is related to *Leptocythere*, according to the zoologists, *Perissocytheridea* has been classified with the Leptocytherinae rather than with the Cytherideinae.

Perissocytheridea? reticulata (van den Bold)

Clithrocytheridea reticulata VAN DEN BOLD, 1957 (part,) Micropaleontology, vol. 3, no. 3, pp. 236, 237, pl. 4, fig. 3a–b (not fig. 3c).

Not *Cytheropteron* sp. *B*, KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 226, pl. 5, fig. 7.

The Recent form is now considered to be a different species or subspecies; it differs slightly in lateral outline from the fossil one, and has somewhat weaker reticulation. The few specimens from the Morne Diablo Quarry are also slightly different in shape, and should be referred to as *Perissocytheridea* sp.

Range: Miocene (*Globigerinatella insueta* zone to *Globorotalia menardii* zone). The species occurs regularly in the Brasso formation. Although the shape is rather different from that of the type species of *Perissocytheridea*, the hinge and the marginal area with widely spaced radial pore canals, some of which do not reach the outer margin, show much more relationship to *Perissocytheridea* than to *Clithrocytheridea*, to which genus the writer originally assigned this species.

Genus **Munseyella** van den Bold, 1957

Toulminia MUNSEY, 1953, Jour. Pal., vol. 27, p. 6 (not *Toulminia* Zittel, 1878).

Munseyella VAN DEN BOLD, 1957, Micropaleontology, vol. 3, no. 1, p. 7.

Type species: Toulminia hyalokystis Munsey, 1953, Jour. Pal., vol. 27, p. 7, pl. 2, figs. 26–27; text-fig. 1.

Description: Carapace small, compressed, quadrangular, highest anteriorly, widest slightly behind the middle. Anterior end rounded, dorsal margin straight or slightly sinuate, ventral margin sinuate, converging posteriorly; posterior end truncate, usually bearing two short, stout

spines in each valve. Anterior end and usually posterior end heavily rimmed. Surface of the valves usually heavily ornamented with broad heavy ridges.

Hinge consists in the right valve of rounded terminal teeth between which extends a long denticulate groove, which forms small sockets at both ends. The left valve has open terminal sockets and a crenulate bar, which broadens at both ends and carries small knob-like teeth.

Marginal area broad in anterior end. Line of concrescence and inner margin do not coincide at the ends. In the anterior end the line of concrescence forms a loop in the direction of the outer margin, somewhat similar to that of *Krithe*. Pore canals short and wide in the loop part, numbering about eight to ten in the species examined. Above the loop in the anterior end there are usually two long pore canals. In the posterior end a smaller but similar loop may exist. Normal pore canals widely scattered. They are of the sieve type. Muscle scar not clearly seen in the material at hand. It appears to consist of a vertical row of four scars, with one in front, the shape of which could not be ascertained. Sexual dimorphism occurs, the males being slightly longer and thinner.

Observed vertical range: Upper Cretaceous to Recent.

Ecology: Marine, in both shallow and deep water.

Relationships: This genus may be related to the genus *Leptocythere*. Recent species have been observed in the Caribbean, the Indo-Pacific, and the seas around New Zealand. Fossil species are known from the Caribbean and the United States Gulf Coast.

Munseyella minuta (van den Bold)
Plate 4, figure 1a–e; plate 5, figure 2a–c

Cytheromorpha minuta VAN DEN BOLD, 1946, *Contribution to the Study of Ostracoda*, p. 103, pl. 14, fig. 12a–b.
Munseyella minuta (van den Bold). – VAN DEN BOLD, 1957, Micropaleontology, vol. 3, no. 3, p. 238.

Carapace small, thick, highest at anterior cardinal angle; dorsal and ventral margins nearly straight and converging posteriorly; anterior end obliquely rounded, posterior end vertically truncate, bearing two stout spines in each valve.

Ornamentation: Heavy anterior ridge, which continues as a ventral ridge parallel to the ventral margin. Behind the posterior end of this ridge the carapace appears to be compressed posteroventrally. From near the end of the ventral ridge another ridge runs obliquely forward and upward, splitting into two curved, more or less parallel ridges toward the anterodorsal part of the carapace. Dorsal ridge slightly curved, more or less parallel to the dorsal margin and partly obscuring it. The posterior end of the dorsal ridge is thickened, sometimes almost knob-like. Development of the ridges in the centre of the carapace rather variable. Some ridges are more pronounced in some specimens, others are more pronounced in other specimens. At first it was thought possible to recognize at least three different subspecies on the basis of the development of these ridges, but no restricted stratigraphic range could be found for any of them, and there appears to be little practical value in trying to separate them.

The specimen figured in plate 4, figure 1a, is almost identical to the holotype, from the Miocene of Cuba. The specimen figured in plate 4, figure 1b, is very close to *Cytheromorpha subminuta* Puri (Puri, 1953*c*, p. 276, pl. 6, figs. 9–10; text-fig. 11i–j), but differs in several details from typical specimens from the Ecphora zone of the Florida Miocene (see pl. 5, fig. 3, in the present paper), e.g., the development of the anterior marginal area.

Dimensions: Holotype (Miocene, Cuba): Length 0.35 mm.; height 0.18 mm.; width 0.15 mm. Trinidad material: Female: Length 0.33–0.40 mm.; height 0.18–0.24 mm.; length–height ratio 0.50–0.61. Male: Length 0.34–0.37 mm.; height 0.17–0.18 mm.; length–height ratio 0.46–0.53.

The species occurs in Trinidad in the Cipero formation (*Globorotalia ciperoensis* zone to *Globorotalia fohsi robusta* zone), the Brasso formation (*Globigerinatella insueta* zone to *Globorotalia fohsi sensu lato* zone), the Karamat formation (*Globorotalia fohsi robusta* and *Globorotalia mayeri* zones), the Lengua formation (*Globorotalia menardii* zone), the Cruse formation, and in the Mejias Quarry (*Globigerina dissimilis* zone).

Range: Oligocene to Middle Miocene.

Munseyella muehlemanni van den Bold

Munseyella muehlemanni VAN DEN BOLD, 1957 (part), Micropaleontology, vol. 3, no. 3, p. 238 (part), pl. 3, fig. 4a–c.

Correction: The anterior marginal area as figured in pl. 3, fig. 4c, of the above-mentioned paper is wrong. Actually only the outer part of the marginal pore canals could be seen, and the continuation toward the inner margin was surmised. In view of the fact that other members of this genus show an anterior loop of the line of concrescence, it is quite probable that this is also the case in *Munseyella muehlemanni*, although it cannot be seen in the available material.

The species is taken here in a more restricted sense than originally, and appears to be confined to the Lengua and Cruse formations. The specimens referred to it from the Morne Diablo Quarry and the Brasso formation belong to a different species, which is described here under the name of *Munseyella punctata* van den Bold, n. sp.

Munseyella punctata van den Bold, **new species**
Plate 5, figure 1a–b

Munseyella muehlemanni VAN DEN BOLD, 1957 (part), Micropaleontology, vol. 3, no. 3, p. 238 (part) (not pl. 3, fig. 4a–c).

Carapace elongate ovate, highest at anterior cardinal angle. Anterior end regularly rounded; dorsal and ventral margins gently convex, converging posteriorly; posterior end sharply rounded above, vertically truncate in the female, slightly obliquely truncate in the male, exhibiting in each valve two small tubercles. Dorsal view spindle-shaped, with wide anterior rim behind which the carapace is strongly compressed. Posterior end regularly tapering, not with posterior ridge as in the other species of *Munseyella*. Greatest width just behind the middle. The ornamentation consists of deep punctations rather than of reticulations. Anterior marginal rim high but narrow, continuing parallel to the ventral margin; dorsal ridge weak, connected to the ventral ridge in the posterior part by semicircular faint ridges. In the anterior half the rows of punctations run parallel to the anterior ridge, on the one hand, and form almost horizontal lines on the other. In the centre of the carapace the punctations form vertical depressed rows between which some of the ridges stand out. One of the more ventral of these horizontal lines is more pronounced than the others, forming a ridge, gently stepping up toward the anterior end, and the carapace is compressed below this ridge. This arrangement of the punctations is easily visible only in the more ornamented specimens. Other specimens merely show a punctate surface.

Only closed carapaces have been found; one of them was opened, and a marginal area very similar to *Munseyella minuta* (van den Bold) could be observed. However, the quality of the specimen did not allow an accurate drawing to be made. The species is close to *Munseyella muehlemanni* van den Bold, but the posterior end does not show the thickened vertical ridge, so that the dorsal view is different. A closely related species has been found in the Miocene of Venezuela, but the marginal area shows more resemblance to that of *Munseyella subminuta* (Puri).

Dimensions:

Holotype: Length: 0.31 mm.; height 0.18 mm.; width 0.14 mm.

Morne Diablo specimens: Length: 0.36 mm.; height 0.20 mm.; width 0.17 mm.

Holotype: A complete carapace from Rohr sample 21 (text-fig. 1, line II, loc. H). U. S. Nat. Mus. no. 562643.

Paratypes: Five specimens, U. S. Nat. Mus. no. 562644.

Occurrence: Brasso formation (*Globigerinatella insueta* zone to *Globorotalia fohsi sensu lato* zone); Karamat formation (*Globorotalia fohsi robusta* and *Globorotalia mayeri* zones); and Morne Diablo Quarry.

Subfamily HEMICYTHERINAE

Genus ORIONINA Puri, 1953

Orionina bermudae (Brady)? Plate 5, figure 9

Orionina bermudae (Brady). – VAN DEN BOLD, 1957, Micropaleontology, vol. 3, no. 3, p. 242.

In the Caribbean Sea, two very similar-looking species occur which differ in their marginal areas. The first species has not been separated here from the fossil one and is referred to as *Orionina bermudae* (Brady)? (pl. 5, fig. 9). The second, which is more elongate, is probably identical with the species described by Hartmann (1956, p. 36, text-figs. 45–52) as *Cythereis* (*Elofsonella*) *reticulata* Hartmann from Brazil (pl. 5, fig. 8). It is not certain which one of these two was described by Brady as *Cythere bermudae*.

F. C. P. M. van Morkhoven, palaeontologist with the N. V. de Bataafsche Petroleum Maatschappij in The Hague, has called my attention to the fact that in most of the Recent material and in a part of the fossil material it is observable that the inner lamella of *Orionina* and *Caudites* is calcified to a greater extent than is usual in the Hemicytherinae. Part of the inner lamella is attached to the outer lamella, and the interior of the valve is in communication with the vestibulum through narrow channels. Edwards' figure (1944, pl. 85, fig. 27) of *Cythereis vaughani* (Ulrich and Bassler) suggests that he also saw this phenomenon. A similar marginal zone occurs in a species of *Heterocythereis?* from the later Neogene of Costa Rica (see pl. 5, fig. 7), which is very close to *Hemicythere dalli* Howe and Brown (Howe *et al.*, 1935, p. 28, pl. 2, figs. 1–3; pl. 4, fig. 18). For a figure of *Heterocythereis* see Wagner (1957, pl. 24). In most fossil specimens the calcified portion of the inner lamella is broken off with a smooth edge (probably along a line visible in transmitted light in the Recent specimens), and only the supporting pillars remain as rounded spots on the inside of the outer lamella. The nature of this line, whether a list or an indentation in the inner lamella, could not be ascertained so far. It has not shown up in transverse sections of the broken valve.

Subfamily TRACHYLEBERIDINAE?

Genus AMBOCYTHERE van den Bold, 1958

Ambocythere aff. **hyalina** van den Bold

Ambocythere aff. *hyalina* VAN DEN BOLD, 1958, Ann. Mag. Nat. Hist., ser. 12, vol. 10 (1957), p. 807, text-fig. 8.

This species has been found only at Kugler loc. 2845, *Globigerinatella insueta* zone.

Ambocythere? sulcata van den Bold

Ambocythere? sulcata VAN DEN BOLD, 1958, Ann. Mag. Nat. Hist., ser. 12, vol. 10 (1957), p. 811, text-figs. 11–12, 19.

This species has been found in Rohr sample 4719, Tunnel Hill "member," and in Rohr sample 11637, Esmeralda "member." It occurs also in the Los Atajos conglomerate.

Subfamily TRACHYLEBERIDINAE

Genus TRACHYLEBERIS Brady, 1898

Trachyleberis exanthemata gomillionensis (Howe and Ellis)

Cythereis exanthemata var. *gomillionensis* HOWE AND ELLIS in HOWE ET AL., 1935, Florida, Geol. Survey, Bull., no. 2, p. 19, pl. 1, figs. 6–12; pl. 4, fig. 3. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 88, pl. 9, fig. 19. – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 83.

Actinocythereis exanthemata gomillionensis (Howe and Ellis). – PURI, 1953, Amer. Midland Nat., vol. 49, p. 181, pl. 2, figs. 1–2. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 253, pl. 13, figs. 16–17. – MCLEAN, 1957, Bull. Amer. Pal., vol. 38, no. 167, p. 83, pl. 10, fig. 2a–d.

Trachyleberis exanthemata var. *gomillionensis* (Howe and Ellis). – MALKIN, 1953, Jour. Pal., vol. 27, p. 792, pl. 81, figs.16–17.

Only a few specimens of this species have so far been found in Trinidad, in the upper Navarro River "member," *Globorotalia fohsi sensu lato* and *Globorotalia fohsi lobata* zones.

Genus PTERYGOCYTHEREIS Blake, 1931

Pterygocythereis americana (Ulrich and Bassler)

Cythereis cornuta var. *americana* ULRICH AND BASSLER, 1904, Maryland Geol. Survey, Miocene, p. 122, pl. 37, figs. 29–33.

Not *Cythereis (Pterygocythereis) cornuta* var. *americana* Ulrich and Bassler. – HOWE ET AL., 1935, Florida, Geol. Survey, Bull., no. 2, p. 26, pl. 2, figs. 19, 21, 24; pl. 4, fig. 24.

Not *Cythereis (Pterygocythereis) cornuta* var. *americana* Ulrich and Bassler. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 100, pl. 10, fig. 17.

Not *Pterygocythereis cornuta* var. *americana* Ulrich and Bassler. – SWAIN, 1948, Maryland, Dept. Geol., Mines and Water Resources, Bull., no. 2, p. 206, pl. 13, fig. 4 = *Pterygocythereis howei* Hill.

Pterygocythereis americana (Ulrich and Bassler). – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, pp. 83, 84. – HILL, 1954, Jour. Pal., vol. 28, p. 814, pl. 99, fig. 7a. – MCLEAN, 1957, Bull. Amer. Pal., vol. 38, no. 167, p. 80, pl. 9, figs. 5a–d, 6a–e.

Pterygocythereis cornuta americana (Ulrich and Bassler). – SWAIN, 1952, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 41. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 261 (part), pl. 13, fig. 1; text-fig. 9f (not pl. 13, figs. 2–5; not text-fig. 9d–e).

Only seven specimens of this species have been found so far in Trinidad, all in the *Globorotalia fohsi lobata* zone of Montserrat well no. 1. In all but one of the specimens, the fluted dorsal crests are damaged.

Genus CATIVELLA Coryell and Fields, 1937

Cativella navis Coryell and Fields
Plate 3, figure 4

Cativella navis CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 9, text-fig. 9. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 104, pl. 12, fig. 11. – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 85. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 262, pl. 11, figs. 3–7; text-fig. 9i–k.

Navecythere delicatula CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 7, text-fig. 7.

Range: Lower Miocene (*Globorotalia barisanensis* zone) to Pliocene.

Occurrence: Upper Navarro River "member."

Cativella aff. **semitranslucens** (Crouch)
Plate 3, figure 3

Trachyleberis semitranslucens CROUCH, 1949, Jour. Pal., vol. 23, pp. 597–598, pl. 96, fig. 1.

Bradleya? sp., KEY, 1954, K. Nederl. Akad. Wetensch., Verh., ser. 2, vol. 20, p. 223, pl. 4, fig. 13a–c; pl. 6, fig. 10.

?Cythereis alata HARTMANN, 1956, Beitr. Neotrop. Fauna, vol. 1, no. 1, p. 39, text-figs. 53–63.

?Cativella cf. *semitranslucens* (Crouch). – VAN DEN BOLD, 1957, Micropaleontology, vol. 3, no. 3, p. 243, pl. 2, fig. 6.

In the Trinidad material of this species, the fluted crests which form the main ornamentation have often been damaged, just as can be seen in Puri's figures of *Cativella navis* (see synonymy of preceding species). In the Recent specimens, 70 per cent were undamaged, 20 per cent had the crests partly replaced by rows of nodules, and in 10 per cent only rows of nodules remained. In the Brasso material, only 40 per cent had undamaged crests, another 40 per cent had part of the ridges replaced by rows of nodules, and in 20 per cent only nodules were present. The latter specimens resemble *Cativella? crassa* van den Bold (1950, p. 85, pl. 18, fig. 5) but have a thinner anterior ridge without large blunt nodules.

Dimensions: Length 0.63 mm.; height 0.33 mm.

The species is very close to *Cythereis semitranslucens* Crouch, but is much smaller. The present author therefore hesitates to consider them specifically identical.

Range: Oligo-Miocene (*Globigerinatella insueta* zone) to Recent.

Occurrence: Throughout the Brasso formation.

Genus PURIANA Coryell and Fields, 1953

Puriana rugipunctata (Ulrich and Bassler)
Plate 3, figure 2

Cythere rugipunctata ULRICH AND BASSLER, 1904, Maryland, Geol. Survey, Miocene, p. 118, pl. 38, figs. 16–17.

Cythereis rugipunctata (Ulrich and Bassler). – HOWE ET AL., 1935, Florida, Geol. Survey, Bull., no. 2, p. 23, pl. 1, figs. 18, 20–22; pl. 4, figs. 16–17.

Favella rugipunctata (Ulrich and Bassler). – EDWARDS, 1944, Jour. Pal., vol. 18, p. 524, pl. 88, figs. 5–6. – VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 100, pl. 10, fig. 3. – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 86.

Trachyleberis rugipunctata (Ulrich and Bassler). – SWAIN, 1951, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 38, pl. 6, fig. 8.

Puriana rugipunctata (Ulrich and Bassler). – PURI, 1953, Jour. Pal., vol. 27, p. 751. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 257, pl. 12, figs. 18–19; text-fig. 8k. – MCLEAN, 1957, Bull. Amer. Pal., vol. 38, no. 167, p. 89, pl. 11, fig. 5a–d.

Range: Lower Miocene (*Globorotalia fohsi barisanensis* zone) to Recent.

Occurrence: Navarro River "member" of the Brasso formation. It is quite common in younger shallow-water deposits: the Los Atajos conglomerate, Springvale formation, and Talparo formation.

Genus BUNTONIA Howe, 1935

Buntonia guntheri van den Bold, **new species**
Plate 3, figure 5a–d

Female: Carapace ovate, highest at anterior cardinal angle. Anterior end evenly rounded; dorsal margin straight in the right valve, obscured in the middle by a curved dorsal ridge; dorsal margin in the left valve convex, with a well-marked posterior cardinal angle; ventral margin convex in the left valve, sinuate in the right; posterior end angled in the middle, straight above in the left valve, concave in the right; the ventral part of the posterior end is the upwardly swept continuation of the ventral margin. Left valve overlapping the right at the anterior cardinal angle and along the dorsal margin, the dorsal part of the posterior end, and the ventral margin. Dorsal view spindle-shaped, widest in the middle, ends compressed.

Surface deeply punctate, the punctations being larger in the centre and becoming smaller toward the periphery. From the centre backward the punctations are grouped into longitudinal rows separated by ridges. In some specimens these ridges are hardly discernible; in others up to seven distinct ridges can be recognized.

Male: Carapace similar to the female, but more slender. Hinge in the right valve with large, rounded terminal teeth and an intermediate crenulate groove, at the anterior end of which an elongate, rather shallow socket occurs. Inner margin and line of concrescence coincide; marginal pore canals numerous, narrow, and simple.

Dimensions:

Female: Length 0.52 mm.; height 0.32 mm.; width 0.24 mm.

Male: Length 0.56 mm.; height 0.32 mm.; width 0.22 mm.

This species has been named in honour of A. E. Gunther, formerly a geologist with Shell Trinidad Ltd.

The species has been found only in the Navarro River "member" of the Brasso formation (*Globorotalia fohsi sensu lato* zone). At its type locality the species occurs together with *Cytherella polita* Brady, *Cytherella* aff. *pulchra* Brady, *Haplocytheridea subovata* (Ulrich and Bassler), *Cyprideis bronnimanni* n. sp., *Costa variabilocostata* (van den Bold), *Orionina bermudae* (Brady)?, *Basslerites minutus* n. sp., and *Luvula palmerae* Coryell and Fields.

Holotype: A complete carapace from Gunther loc. 2090, about ¾ mile north of Biche Quarry (text-fig. 1, line V). U. S. Nat. Mus. no. 562069.

Genus COSTA Neviani, 1928

Costa variabilocostata seminuda van den Bold, **new subspecies**
Plate 3, figure 1a–b

Carapace highest at the anterior cardinal angle. Anterior end obliquely rounded, rimmed, practically smooth above the middle, denticulate below; up to five of the lower denticles may become rather strong spines; dorsal margin straight, partly obscured in side view by a curved dorsal ridge; ventral margin slightly sinuate, subparallel (females?) or gently converging posteriorly (males?); posterior end angled at the middle, concave above, convex and bearing about seven teeth below. Ornamentation consists of a reticulate pattern in which, in typical specimens, only a dorsal and ventral ridge are developed, the latter bearing a spine at its posterior end. Other specimens are intermediate between the typical form of the species and the typical form of the subspecies *seminuda*. These specimens exhibit a weak median ridge which tends to split into two parallel ridges in front of the middle, as in *Costa variabilocostata*.

Dimensions:

Female?: Length 0.61 mm.; height 0.35 mm.; width 0.29 mm.

Male?: Length 0.67 mm.; height 0.36 mm.; width 0.28 mm.

Range: Lower Miocene (*Globorotalia fohsi barisanensis* zone or upper part of *Globigerinatella insueta* zone to *Globorotalia fohsi robusta* zone).

Occurrence: In Tunnel Hill and lower Navarro River "members."

Type specimen: A complete carapace from Rohr sample 12383 (south end of line II, text-fig. 1), *Globorotalia fohsi robusta* zone. U. S. Nat. Mus. no. 562067.

Genus BASSLERITES Howe, 1937

Basslerites minutus van den Bold, **new species**
Plate 3, figure 8; plate 5, figure 5a–c

Basslerites teres (Brady). – KEY, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 224, pl. 5, fig. 2a–b.

Not *Cythere teres* BRADY, 1870, in DE FOLIN AND PERIER, *Les fonds de la mer*, vol. 1, pts. 12–14, p. 147, pl. 14, figs. 17–18.

Basslerites berchoni (Brady). – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, no. 1, p. 85. – 1957, Micropaleontology, vol. 3, no. 3, p. 244.

Not *Cythere berchoni* BRADY, 1870, in DE FOLIN AND PERIER, *Les fonds de la mer*, vol. 1, pts. 12–14, p. 117, pl. 14, figs. 3–4.

Carapace elongate ovate, bean-shaped, smooth. Anterior end evenly rounded; dorsal and ventral margins slightly convex and parallel; posterior end obtusely angled at the posterior cardinal angle, dorsally subtruncate in the left valve, broadly rounded in the right valve. Left valve overlapping the right along dorsal and ventral margins. Greatest width behind the middle, just in front of a shallow submedian depression in the posterior part of the carapace. Sexual dimorphism only very slight.

Marginal area rather broad in anterior end, where line of concrescence and inner margin do not coincide. Radial pore canals of moderate number (about twenty); it appears to be characteristic that they tend to join at the base, two of them forming a V, a few branching. In the posterior end, the marginal pore canals are simple.

Hinge consists of large, blunt terminal teeth in the right valve, separated by a crenulate groove which has a deep but narrow socket at its anterior end. In the left valve there are large, rounded terminal sockets; anterior tooth narrow, connected with a narrow, crenulate bar.

The marginal pore canals in the Recent specimens of *Basslerites minutus* are arranged slightly differently as compared with those of the Miocene specimens (compare figures 5a and 5b of plate 5). The whole habitus, however, is identical, and the writer does not feel justified at present in separating the two forms.

Dimensions:		Length	Height	Width
Gulf of Paria:	Female:	0.39	0.22	0.17 mm.
	Male:	0.44	0.23	0.17
Brasso formation:	Female:	0.39	0.23	0.17
	Male:	0.42	0.23	0.17

Range: *Globorotalia fohsi barisanensis* zone to Recent.

Occurrence: Upper Tunnel Hill and Navarro River "members" of the Brasso formation. Common in younger Tertiary shallow-water deposits.

Remarks: The writer (see synonymy) erroneously identified *Basslerites miocenicus* (Howe) with *Basslerites berchoni* (Brady). But the *Basslerites* from the harbour of Port Said, which in all probability is the real *Basslerites berchoni* and which appears to be identical with *Cythereis teres* (Brady) as described by Müller (1894, p. 379, pl. 29, figs. 6, 15) and with *Basslerites teres* (Brady) as described by Ruggieri (1950, p. 42, text-fig. 26) and later corrected to *Basslerites berchoni* (Brady) (Ruggieri, 1953, p. 169), has no depression in the posterior part of the valves such as can be seen in the figures of *Basslerites miocenicus* (Howe) (Howe *et al.*, 1935, pl. 1, fig. 25; see also pl. 5, fig. 6, in the present paper) and in the present species (see pl. 5, fig. 5, and Key, 1954, pl. 5, fig. 2a). Moreover, *Basslerites miocenicus* has simple pore canals and a comparatively large vestibulum (pl. 5, fig. 4), whereas Müller's and Ruggieri's figures of *Basslerites*

PLATE 1

Magnification 50 × unless otherwise indicated.

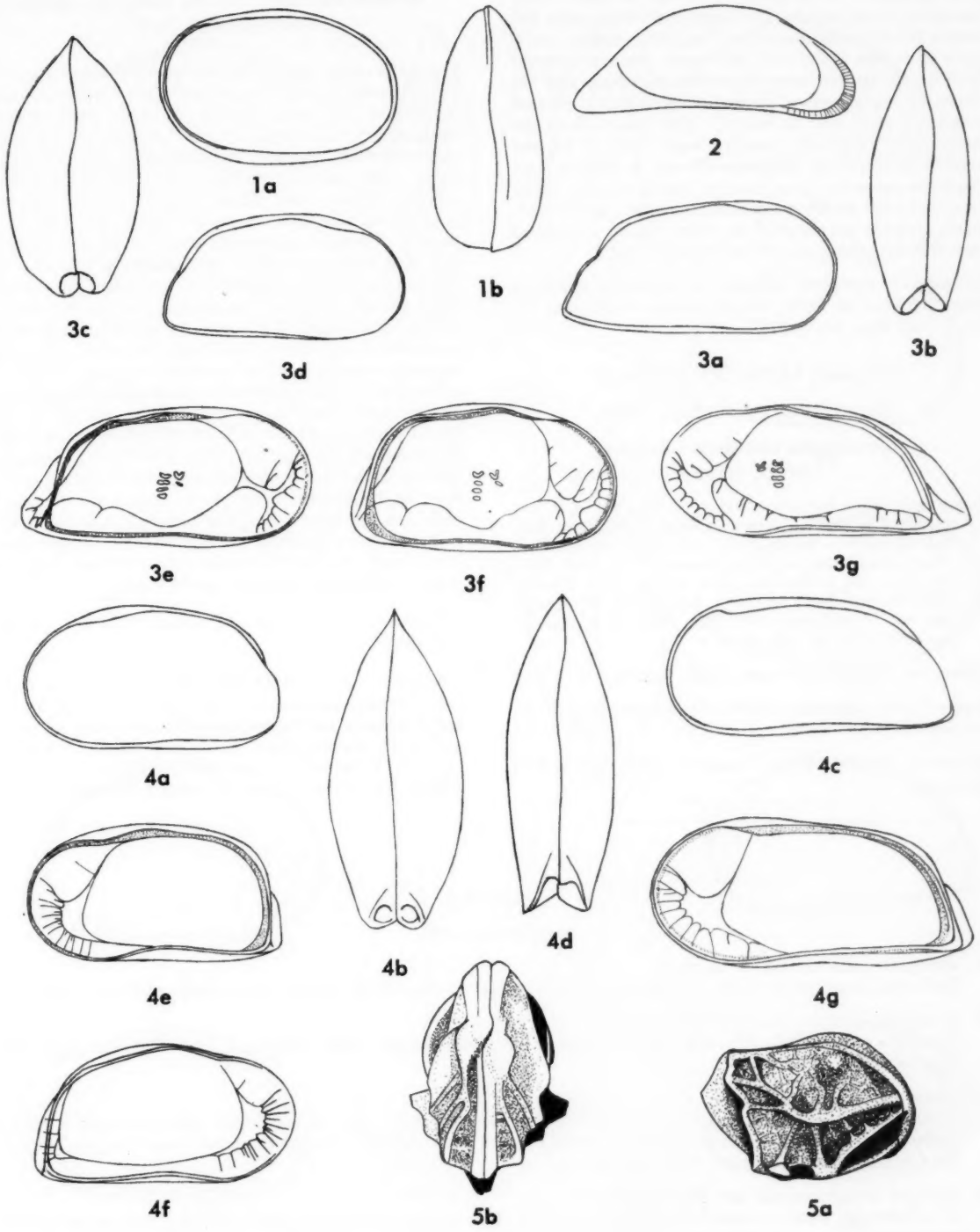
1 *Cytherella* aff. *C. sylverinica* Howe and Lea
Complete carapace from Rohr sample 11637 (text-fig. 1, loc. B): a, left valve view; b, dorsal view.

2 *Macrocypris decora* (Brady)
Exterior of right valve from Rohr sample 33 (text-fig. 1, loc. G, line II).

3 *Krithe trinidadensis* van den Bold, n. sp.
a–b, male carapace: a, right valve view; b, dorsal view; c–d, female carapace: c, dorsal view; d, right valve view; e, male left valve, interior; f, holotype, female left valve, interior; g, male right valve, interior. All from Favre sample 56a, Cipero formation, *Globorotalia fohsi lobata* zone, east of Rio Claro.

4 *Krithe reversa* van den Bold, n. sp.
a–b, female carapace: a, left valve view; b, dorsal view; c–d, male carapace: c, left valve view; d, dorsal view; e, holotype, female right valve, interior; f, female left valve, interior; g, male right valve, interior. All from Favre sample 56a.

5 *Eucytherura? ruggierii* van den Bold, n. sp.
Holotype, complete carapace, × 170: a, right valve view; b, dorsal view. Rohr sample 21 (text-fig. 1, line II, loc. H).


1a
1b
2
3a
3b
3c
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4c
4d
4e
4f
4g
5a
5b

teres indicate a small vestibulum and at least a few branching pore canals. The same difference exists between *Basslerites miocenicus* and *Basslerites minutus* (compare pl. 5, figs. 4 and 5a). Moreover, *Basslerites minutus* is distinctly smaller than *Basslerites miocenicus*, and the shape of the posterior depression is slightly different (compare pl. 5, figs. 5c and 6). The species from the Miocene of Venezuela (van den Bold, 1950*a*, p. 85) described as *Basslerites miocenicus* (Howe) is smaller than *Basslerites miocenicus* from Florida, and is very probably identical with *Basslerites minutus*, but only closed carapaces occur in the material the writer has at present, so that this hypothesis cannot be substantiated.

Holotype: A complete carapace of a female specimen from the Gulf of Paria, gravity station no. 6, line 15. U. S. Nat. Mus. no. 563087.

Subfamily LOXOCONCHINAE

Genus LOXOCONCHA Sars, 1866

Loxoconcha reticularis Edwards
Plate 4, figure 2

Loxoconcha reticularis EDWARDS, 1944, Jour. Pal., vol. 18, p. 527, pl. 88, figs. 26–27. – VAN DEN BOLD, 1950, Jour. Pal., vol. 24, p. 86. – SWAIN, 1951, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 26. – MALKIN, 1953, Jour. Pal., vol. 27, p. 80, pl. 80, figs. 13–17. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 274, pl. 10, fig. 7, text-fig. 10e. – MCLEAN, 1957, Bull. Amer. Pal., vol. 38, no. 167, p. 72, pl. 7, fig. 5a–b.

Dimensions: Length 0.69 mm; height 0.42 mm.

Range: Lower Miocene (*Globorotalia barisanensis* zone to *Globorotalia mayeri* zone).

Occurrence: Navarro River "member" of the Brasso formation.

Loxoconcha? rohri van den Bold, **new species**
Plate 4, figure 5a–b

Carapace ovate, highest in the middle, widest just behind the middle. Anterior end obliquely rounded; dorsal margin in left valve arched, in right valve nearly straight; ventral margin convex; posterior end angled above the middle, slightly concave above, nearly straight below. Left valve overlapping the right along dorsal margin. Dorsal view elliptical, posterior end sharply compressed. Carapace reticulate, with a fine network of meshes. A ventral ridge starts near the anterior margin and runs almost parallel to the ventral margin; just in front of the middle it is joined by a second ridge, which starts near the middle of the anterior margin and curves sharply downward. It obscures the ventral margin from its junction with the ventral ridge backward. It curves up again sharply near the posterior end and continues upward to near the posterior cardinal angle. The postero-ventral curve bears a few short spines, which, except for one, are formed merely by indentations of the ridge. From the anterior part of the ridge two low, irregular, curved ridges run obliquely backward and upward, more or less parallel to the posterior part of the ventral ridge; in the centre they lose themselves between the ridges of the reticulation. As only closed carapaces have been found, the interior could not be studied, and the generic assignment remains questionable.

Dimensions: Length 0.35 mm.; height 0.23 mm.; width 0.21 mm.

The species has the same type of ornamentation as *Loxoconcha carinata* Lienenklaus (1894, p. 235, pl. 16, fig. 5), but it differs in the curved dorsal margin of the left valve and in the ventral ridges. It has been named in honour of Dr. K. Rohr, whose work laid the basis for our present knowledge of the geology of central Trinidad. It has

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PLATE 2

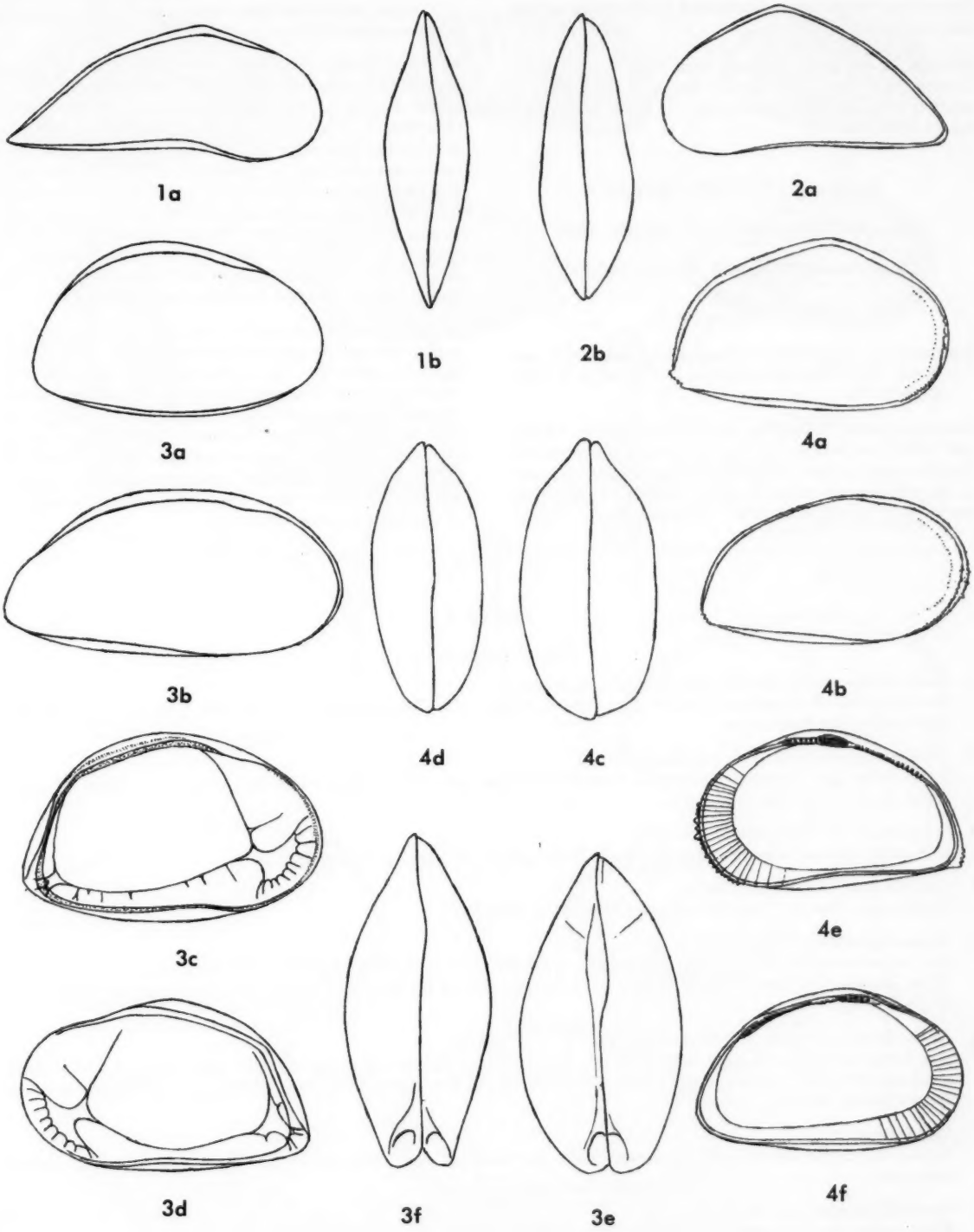
Magnification 80×.

1 *Paracypris stolki* van den Bold, n. sp.
Holotype, complete carapace: a, right valve view; b, dorsal view. Rohr sample 4866, Navarro River "member."

2 *Pontocypris dreikanter* (Coryell and Fields)
Complete carapace: a, left valve view; b, dorsal view. Rohr sample 12460 (text-fig. 1, line III), *Globorotalia fohsi sensu lato* zone.

3 *Krithe* aff. *K. producta* Brady
a, female carapace, right valve view; b, male carapace, right valve view; c, female left valve, interior; d, female right valve, interior; e, female carapace, dorsal view; f, male carapace, dorsal view. All from Wirz sample 214, Cipero formation, *Globorotalia fohsi robusta* zone.

4 *Cyprideis bronnimanni* van den Bold, n. sp.
a, c, holotype, female carapace: a, left valve view; c, dorsal view; b, male carapace, left valve view; d, male carapace, dorsal view; e, female right valve, interior; f, male left valve, interior. All from Bronnimann sample 65, outcrop on the Caparo River, Navarro River "member," *Globorotalia fohsi sensu lato* zone.


1a
1b
2b
2a
3a
4a
3b
4b
4d
4c
3c
4e
3d
3f
3e
4f

been found only in the Tunnel Hill and Esmeralda "members" of the Brasso formation (*Globorotalia barisanensis* zone).

Holotype: A complete carapace from Rohr sample 4719, Tunnel Hill "member" of the Brasso formation (just south of loc. D, line II, text-fig. 1). U. S. Nat. Mus. no. 562070.

Subfamily CYTHERURINAE

Genus EUCYTHERURA G. W. Müller, 1894

Eucytherura? ruggierii van den Bold,
new species
Plate 1, figure 5a–b

Eucytherura sp. cf. *Eucytherura gullentopsi* Ruggieri. – VAN DEN BOLD, 1957, Micropaleontology, vol. 3, no. 3, p. 245, pl. 4, fig. 15.

Carapace ovate, highest in front of the middle, widest just behind the middle. Anterior end obliquely rounded; dorsal margin nearly straight in the right valve, sinuate in the left; ventral margin convex; posterior end angled above the middle, slightly concave above, nearly straight below. Dorsal view irregular, greatest width at a laterally projecting spine behind the middle; posterior end compressed, short.

Carapace finely reticulate, with some irregular raised ridges and some longitudinal ventral ridges. Ventral ridge starting at the anterior margin, slightly convex downward; it is joined in the middle by a very pronounced second ridge which starts just below the middle of the anterior margin. Just behind this junction there is a small depression bordered by two transverse ridges. This depression is divided into two by a laterally projecting spine on the ridge. The posterior edge of the ala formed by the ventral ridge is sharp and irregular. A straight dorsal ridge obscures the posterior part of the dorsal margin and the posterior cardinal angle.

There are differences in size and in the amount of elongation among the various specimens from different formations, although the ornamentation remains very much the same. The specimens from the Morne Diablo Quarry are larger and more elongate than the holotype, from the Navarro River "member" of the Brasso formation, which is comparatively short and small; those from the Tunnel Hill "member" are more elongate, while a specimen from the Forest formation (Upper Miocene) is of the same general shape.

PLATE 3

Magnification 80×.

1 *Costa variabilocostata seminuda* van den Bold, n. subsp.
Holotype, complete carapace: a, left valve view; b, dorsal view. Rohr sample 12383 (text-fig. 1, south end of line II), *Globorotalia fohsi lobata* zone.

2 *Puriana rugipunctata* (Ulrich and Bassler)
Right valve view of complete carapace from Gunther sample 1829, 1⅛ mile west of Biche Quarry, *Globorotalia fohsi sensu lato* zone (text-fig. 1, line V).

3 *Cativella* aff. *C. semitranslucens* (Crouch)
Left valve view of complete carapace from Rohr sample 21 (text-fig. 1, line II, loc. H).

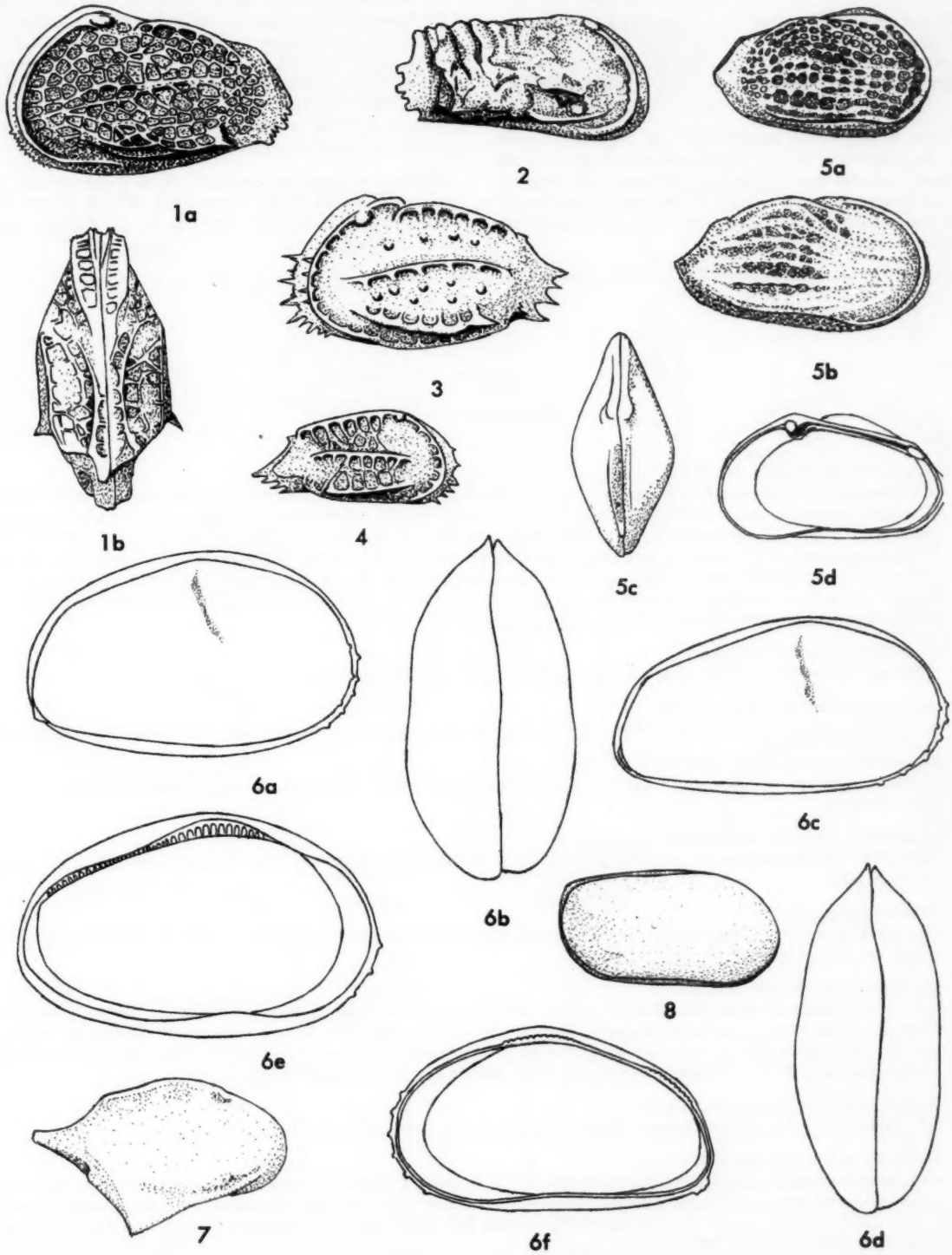
4 *Cativella navis* Coryell and Fields
Right valve view of complete carapace from Rohr sample 21.

5 *Buntonia guntheri* van den Bold, n. sp.
a, c, reticulate specimen: a, right valve view; c, dorsal view; b, smooth specimen, exterior of right valve; d, right valve, interior. All from Gunther sample 1829, 1⅛ mile west of Biche Quarry, *Globorotalia fohsi sensu lato* zone (text-fig. 1, line V).

6 *Haplocytheridea subovata* (Ulrich and Bassler)
a–b, female carapace: a, right valve view; b, dorsal view; c–d, male carapace: c, right valve view; d, dorsal view; e, female left valve, interior; f, male left valve, interior. All from Gunther sample 2090, auger hole ¾ mile north of Biche Quarry (text-fig. 1, line VI).

7 *Cytheropteron* sp.
Exterior of right valve from Rohr sample 4719, just south of loc. D (text-fig. 1, line II), *Globorotalia fohsi barisanensis* zone.

8 *Basslerites minutus* van den Bold, n. sp.
Right valve view of complete carapace from the Gulf of Paria (line 15, station 6).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5b
1b
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5d
6a
6b
6c
6e
8
7
6f
6d

Dimensions:	Length	Height	Width
Navarro River "member":	0.24	0.17	0.18 mm.
Tunnel Hill "member":	0.36	0.21	—
Forest formation:	0.30	0.17	—
Morne Diablo Quarry:	0.35	0.19	0.17

There is a general resemblance to *Loxoconcha? rohri* n. sp., especially in the arrangements of the ventral ridges, but the overall shape is different and suggests more resemblance to species of the genus *Eucytherura*. As the interior could not be studied, the generic assignment remains questionable.

On the basis of some badly preserved specimens from the Morne Diablo Quarry, the writer (1957) tentatively compared this species with *Eucytherura gullentopsi* Ruggieri (1952, pp. 30, 31, pl. 7, figs. 2–4). The Brasso specimens are better preserved and show distinct differences from that species, e.g., the shape of the anterior margin and the presence of the ventral spine, which is absent in *Eucytherura gullentopsi*.

Holotype: A complete carapace from Rohr sample 21, upper Navarro River "member" of the Brasso formation (loc. H, line II, text-fig. 1). U. S. Nat. Mus. no. 562072.

PLATE 4

Magnification 80×.

1 *Munseyella minuta* (van den Bold)
a, right valve view of complete carapace, virtually identical with the holotype, from the Esmeralda estate, Texaco Trinidad catalogue no. 119380, Brasso formation, *Globigerinatella insueta* zone; b, right valve view of complete carapace, similar in ornamentation to *Munseyella subminuta* (Puri), from Calyx well no. 57, at 340–350 feet, Oligocene; c, left valve view of specimen from Moore sample 646, Cruse formation, Balata area, east of Rio Claro; d, right valve view of specimen from Renz sample 103, Cipero formation, *Globigerina ciperoensis* zone; e, right valve view of specimen from Rohr sample 347, outcrop on the Navarro River, close to line II (text-fig. 1), *Globorotalia fohsi barisanensis* zone (Kugler letter dated April 3, 1956).

2 *Loxoconcha reticularis* Edwards
Left valve view of complete carapace from Rohr sample 21 (text-fig. 1, line II, loc. H).

3 *Luvula palmerae* Coryell and Fields
a, c, female carapace: a, left valve view; c, dorsal view; b, male carapace, left valve view. Both from Rohr sample 21.

4 *Cytheropteron subreticulatum* van den Bold
Complete carapace: a, right valve view; b, dorsal view. Rohr sample 4866, outcrop on the Caparo River, south of Brasso village.

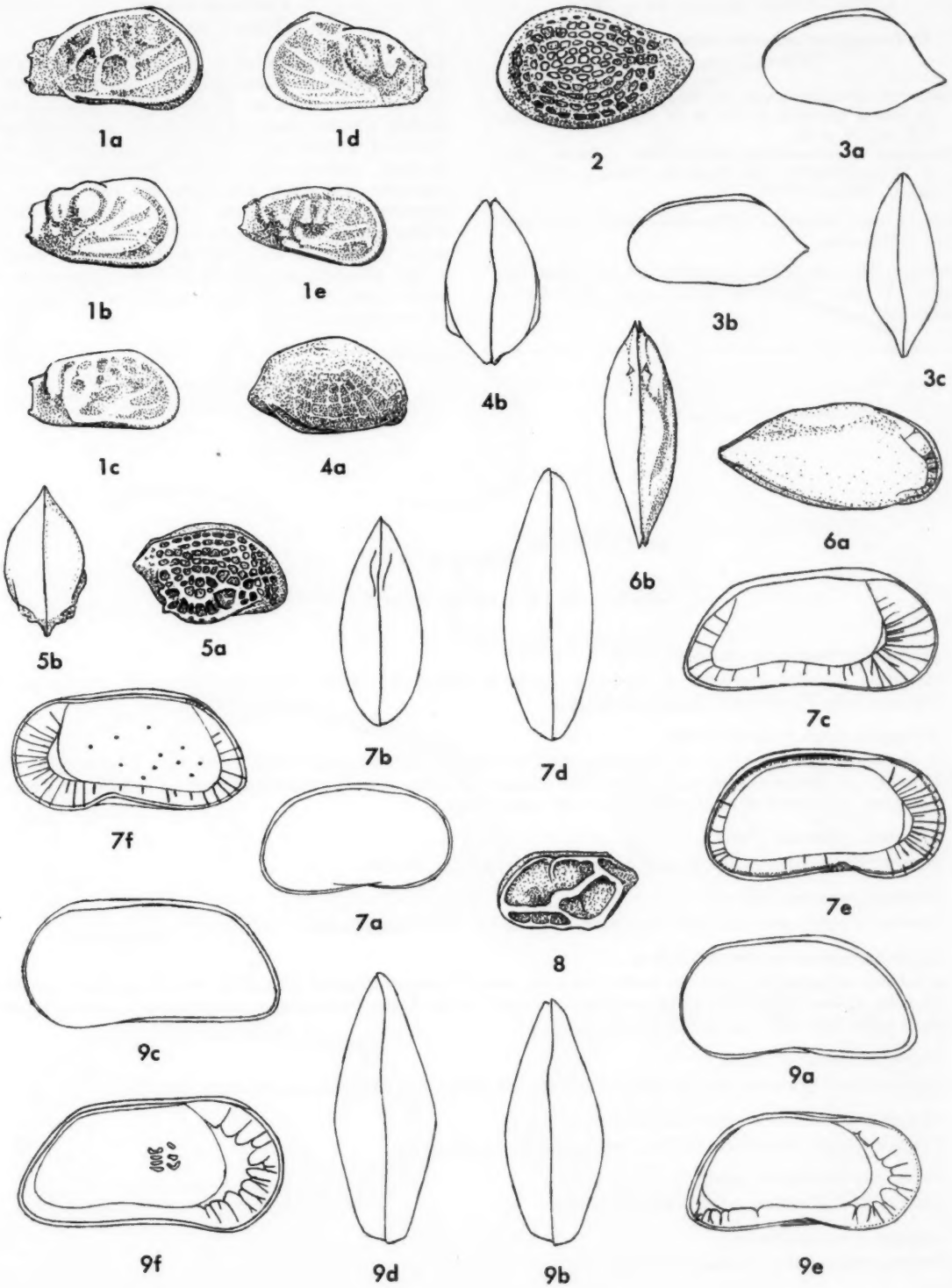
5 *Loxoconcha? rohri* van den Bold, n. sp.
Holotype, complete carapace: a, right valve view; b, dorsal view. Rohr sample 4719, just south of loc. D (text-fig. 1, line II).

6 *Pellucistoma?* sp.
Complete carapace: a, right valve view; b, dorsal view. Rohr sample 48 (text-fig. 1, line II, about midway between loc. F and loc. G).

7 *Parakrithe vermunti* (van den Bold)
a–b, female carapace from Hutchinson sample 3769, Lengua formation, *Globorotalia menardii* zone: a, right valve view; b, dorsal view; c–d, male carapace from Hutchinson sample 3526, Lengua formation, *Globorotalia menardii* zone: c, right valve view; d, dorsal view; e, interior of female left valve from Favre sample 8097, Lengua formation, *Globorotalia menardii* zone; f, interior of female right valve from Favre sample 8097.

8 *Kangarina quellita* Coryell and Fields
Left valve view of complete carapace from Rohr sample 21 (text-fig. 1, line II, loc. H).

9 *Parakrithe reversa* van den Bold, n. sp.
a–b, female carapace from Hutchinson sample 2772, Lengua formation, *Globorotalia menardii* zone: a, left valve view; b, dorsal view; c–d, male carapace from Favre sample 7026, Lengua formation, *Globorotalia menardii* zone: c, left valve view; d, dorsal view; e, interior of female left valve from Favre sample 7026; f, interior of male left valve from Favre sample 7026.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7c
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9c
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9f
9d
9b
9e

Genus CYTHEROPTERON Sars, 1866

Cytheropteron subreticulatum van den Bold
Plate 4, figure 4a–b

Cytheropteron subreticulatum VAN DEN BOLD, 1946, *Contribution to the study of Ostracoda*, p. 113, pl. 14, fig. 6. – 1950, Jour. Pal., vol. 24, p. 86.

?Cytheropteron cf. *subreticulatum* van den Bold. – SWAIN, 1951, U. S. Geol. Survey, Prof. Paper no. 234–A, p. 48, pl. 7, figs. 11, 13.

Range: Lower Miocene (*Globorotalia fohsi barisanensis* zone) to Pliocene.

Occurrence: Navarro River "member" of the Brasso formation. It also occurs in the Lengua and Forest formations.

Cytheropteron sp.
Plate 3, figure 7

Carapace ovate, highest in the middle. Anterior end slightly obliquely rounded; dorsal margin arched in the left valve, sinuate in the right; ventral margin slightly sinuate; posterior end long, slightly upwardly deflected, situated above the middle; ala long, sharply pointed, ending only slightly behind the middle; posterior side sharp and flattened; two shallow depressions in anterior side. There is another shallow depression below the anterodorsal margin and two more in front of and behind the posterior cardinal angle. Marginal area broad, line of concrescence and inner margin coincide, pore canals few. Hinge typical of the genus.

PLATE 5

Magnification 110× unless otherwise indicated.

1 *Munseyella punctata* van den Bold, n. sp.
Holotype, complete specimen: a, right valve view; b, dorsal view. Rohr sample 21 (text-fig. 1, line II, loc. H), Navarro River "member," Brasso formation.

2 *Munseyella minuta* (van den Bold)
a, interior of left valve from Aruba water well, at 780–810 feet, Neogene (Coll. Geol. Inst. Utrecht Univ., no. D.30891); b, interior of left valve from Rohr sample 347, outcrop on the Navarro River, *Globorotalia fohsi barisanensis* zone; c, interior of right valve from Rohr sample 347.

3 *Munseyella subminuta* (Puri)
Anterior marginal area of left valve from the Ecphora zone, Florida.

4 *Basslerites miocenicus* (Howe)
Interior of right valve from the Arca zone, Choctawhatchee stage, Florida.

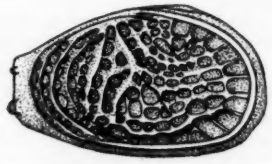
5 *Basslerites minutus* van den Bold, n. sp.
a, interior of right valve from the Gulf of Paria; b, part of anterior marginal area of left valve from Rohr sample 21 (text-fig. 1, line II, loc. H), Navarro River "member" of the Brasso formation; c, indentation of posterior part of right valve from the Gulf of Paria.

6 *Basslerites miocenicus* (Howe)
Indentation of posterior part of right valve from the Arca zone, Choctawhatchee stage, Florida.

7 *Heterocythereis?* aff. *Hemicythere dalli* Howe and Brown
Interior of right valve from the late Neogene of Costa Rica.

8 *Orionina reticulata* (Hartmann)
Interior of right valve, × 140; Recent, Aruba.

9 *Orionina bermudae* (Brady)?
Interior of left valve; Recent, St. Barts.



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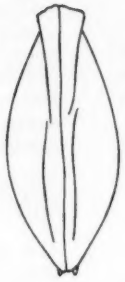

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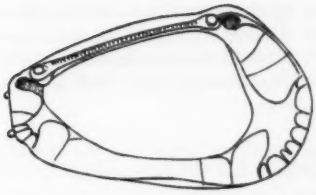

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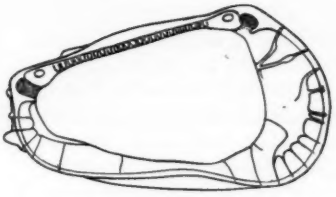

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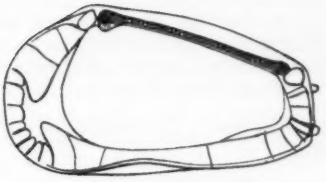

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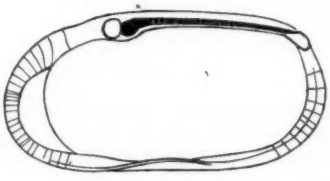

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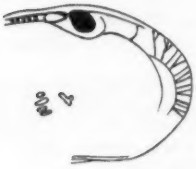

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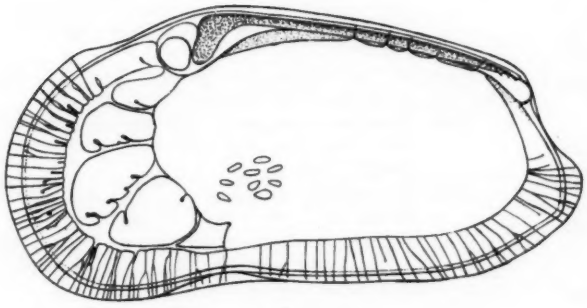

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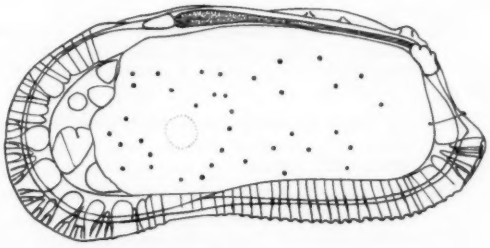

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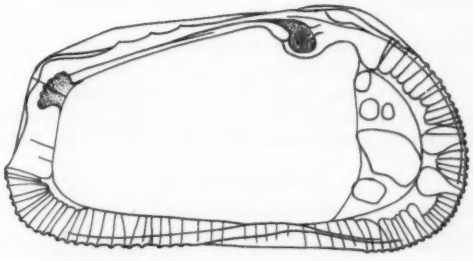

9

Dimensions: Length 0.57 mm.; height 0.30 mm.

A few specimens of this species have been found in the upper Tunnel Hill and upper Navarro River "members," *Globorotalia barisanensis* and *Globorotalia fohsi fohsi* zones. Not enough material is present to establish a new species.

Genus KANGARINA Coryell and Fields, 1937

Kangarina quellita Coryell and Fields
Plate 4, figure 8

Kangarina quellita CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 13, text-fig. 15a–c. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 248, pl. 4, fig. 9. – KEY, 1954, K. Nederl. Akad. Wetensch., Verh., ser. 2, vol. 20, p. 226, pl. 5, fig. 8.

Range: Miocene (*Globorotalia fohsi sensu lato* zone) to Recent.

Occurrence: Upper Navarro River "member."

Genus LUVULA Coryell and Fields, 1937

Luvula palmerae Coryell and Fields
Plate 4, figure 3a–c

Luvula palmerae CORYELL AND FIELDS, 1937, Amer. Mus. Novitates, no. 956, p. 16, text-fig. 16a–b.
?Not *Luvula palmerae* Coryell and Fields. – PURI, 1953, Florida, Geol. Survey, Bull., no. 36, p. 194, pl. 15, fig. 12, text-fig. 13a.

In Puri's figures the position of the posterior end is much higher than in those of Coryell and Fields. The Trinidad specimens agree entirely with the latter figures. Sexual dimorphism present, some specimens being more elongate than others.

Dimensions:

?Female: Length 0.41 mm.; height 0.24 mm.; width 0.17 mm.

?Male: Length 0.43 mm.; height 0.22 mm.; width 0.16 mm.

The species has been found so far only in the upper Navarro River "member" of the Brasso formation (*Globorotalia fohsi sensu lato* zone to *Globorotalia mayeri* zone).

Subfamily PARADOXOSTOMINAE

Genus PELLUCISTOMA Coryell and Fields, 1937

Pellucistoma? sp.
Plate 4, figure 6a–b

Carapace elongate, highest in front of the middle. Anterior end obliquely rounded, dorsal margin convex, ventral margin sinuate, posterior end produced in the middle. There is a shallow elongate depression in the posterodorsal part of the right valve, above which the carapace is slightly swollen. Dorsal view lanceolate, widest in front of the middle.

Marginal area broad in anterior end, with loop of the line of concrescence; pore canals few, short, bifurcating. Only closed carapaces have been found, so that the hinge could not be studied.

Dimensions: Length 0.50 mm.; height 0.26 mm.; width 0.19 mm.

The species is intermediate in shape between *Pellucistoma howei* Coryell and Fields (1937, p. 17, text-fig. 18a–c) and *Pellucistoma kendengensis* (Kingma) (see van den Bold, 1950*a*, p. 96, pl. 18, fig. 6, text-fig. 3). The peculiar dorsal swelling resembles that of *Luvula palmerae* Coryell and Fields as figured by Puri (1953*c*, text-fig. 13a).

Range: Lower(?) to Upper Miocene.

Occurrence: Upper Navarro River "member" (*Globorotalia fohsi fohsi* zone) of the Brasso formation, and Springvale formation.

BIBLIOGRAPHY

AKERS, W. H.
1955 – *Some planktonic foraminifera of the American Gulf Coast and suggested correlation with the Caribbean Tertiary.* Jour. Pal., vol. 20, no. 4, pp. 647–664.

BOLD, W. A. VAN DEN
1946 – *Contribution to the study of Ostracoda with special reference to the Cretaceous and Tertiary microfauna of the Caribbean region.* (Utrecht, Univ., thesis.) Amsterdam: De Bussy, pp. 8–167, pls. 1–18, text-figs. 1–8, tables 1–6, 2 maps.
1950*a* *Miocene Ostracoda from Venezuela.* Jour. Pal., vol. 24, no. 1, pp. 76–88, pls. 18–19, text-figs. 1–4.
1950*b* *Hemikrithe, a new genus of Ostracoda from the Indo-Pacific.* Ann. Mag. Nat. Hist., ser. 11, vol. 3, pp. 900–904, text-fig. 1a–d.
1957*a* *Ostracoda from the Paleocene of Trinidad.* Micropaleontology, vol. 3, no. 1, pp. 1–18, pls. 1–4.
1957*b* *Oligo-Miocene Ostracoda from southern Trinidad.* Micropaleontology, vol. 3, no. 3, pp. 231–254, pls. 1–4, text-figs. 1–2, table 1.
1958 – *Ambocythere, a new genus of Ostracoda.* Ann. Mag. Nat. Hist., ser. 12, vol. 10 (1957), pp. 801–813, text-figs. 1–21.

BOLLI, H. M.
1950 – *The direction of coiling in the evolution of some Globorotaliidae.* Cushman Found. Foram. Res., Contr., vol. 1, pp. 82–89.

BRADY, G. S.
1866 – *On new or imperfectly known species of marine Ostracoda.* Zool. Soc. London, Trans., vol. 5, pp. 359–393, pls. 57–62.
1868*a* *Ostracoda.* In: FOLIN, L. DE, AND PÉRIER, L., *Les fonds de la mer.* Paris: Vol. 1, pts. 6–7, pp. 49–112.
1868*b* *Contribution to the study of Entomostraca; No. II – Marine Ostracoda from the Mauritius.* Ann. Mag. Nat. Hist., ser. 4, vol. 2, pp. 178–183.

1868*c* *Contributions to the study of Entomostraca; No. III – Marine Ostracoda from Tenedos.* Ann. Mag. Nat. Hist., ser. 4, vol. 2, pp. 220–224.

1868*d* *A monograph of the Recent British Ostracoda.* Linnean Soc. London, Trans., vol. 26, pt. 2, pp. 353–495, 19 pls.

1870 – *Ostracoda.* In: FOLIN, L. DE, AND PÉRIER, L., *Les fonds de la mer.* Paris: Vol. 1, pts. 12–14, pp. 177–256.

1880 – *Report on the Ostracoda dredged by H.M.S. "Challenger" during the years 1873–1876.* Rept. Voy. Challenger, Zool., vol. 1 (pt. 3), pp. 1–184, pls. 1–44.

BRADY, G. S., AND NORMAN, A. M.
1889 – *Monograph of the marine and freshwater Ostracoda of the North Atlantic and northwest Europe; Sect. I – Podocopa.* Roy. Dublin Soc., Sci. Trans., ser. 2, vol. 4, pp. 63–270, pls. 8–23.

CHAPMAN, F.
1906 – *On some foraminifera and Ostracoda obtained off Great Barrier Island, New Zealand.* New Zealand Inst., Trans. Proc., vol. 38 (1905), pp. 77–107, pl. 3.

1916 – *Caenozoic geology of the Mallee and other Victorian bores.* Victoria, Geol. Survey, Rec., vol. 3, pp. 327–430.

CHAPMAN, F., AND CRESPIN, E.
1928 – *Description of Ostracoda.* In: CHAPMAN, F., *The Sorrento bore, Mornington Peninsula.* Victoria, Geol. Survey, Rec., vol. 5, pp. 5–195, pls. 1–12.

CORYELL, H. N., AND FIELDS, S.
1937 – *A Gatun ostracod fauna from Panama.* Amer. Mus. Novitates, no. 956, 18 pp., text-figs., 1 map.

CROUCH, R. W.
1949 – *Pliocene Ostracoda from southern California.* Jour. Pal., vol. 23, no. 6, pp. 594–599, pl. 96.

DOEGLAS, D. J.
1931 – *Ostracoda from northeast Borneo.* Netherlands Indies, Dienst Mijnb., Wetensch. Meded., no. 17, pp. 25–54, 2 pls., 1 text-fig.

EDWARDS, R. E.
1944 – *Ostracoda from the Duplin marl (Upper Miocene) of North Carolina.* Jour. Pal., vol. 18, no. 6, pp. 505–528, pls. 85–88.

EGGER, J. G.
1858 – *Die Ostrakoden der Miozänschichten bei Ortenburg in Nieder-Bayern.* Neues Jahrb. Min. etc., pp. 403–443, pls. 14–19.

1901 – *Ostrakoden aus Meeresgrund-Proben gelothet von 1874–1876 von S.M.S. "Gazelle."* K. Bayer. Akad. Wiss. München, Math.-Physik. Cl., Abh., vol. 21 (1902), pt. 2 (1900–1901), pp. 413–477, 8 pls.

HARTMANN, G.
1956 – *Weitere neue marine Ostracoden aus Brasilien.* Beitr. Neotrop. Fauna, Jena, vol. 1, no. 1, pp. 19–62.

HILL, B. L.
1954 – *Reclassification of winged Cythereis and winged Brachycythere.* Jour. Pal., vol. 28, no. 6, pp. 804–826, pls. 97–100.

HOWE, H. V.
1934 – *The ostracod genus Cytherelloidea in the Gulf Coast Tertiary.* Jour. Pal., vol. 8, no. 1, pp. 29–34, pl. 5.

HOWE, H. V., AND OTHERS
1935 – *Ostracoda of the Arca zone of the Choctawhatchee Miocene of Florida.* Florida, Geol. Survey, Bull., no. 13, pp. 7–37, pls. 1–4.

HOWE, H. V., AND LAW, J.
1936 – *Louisiana Vicksburg Oligocene Ostracoda.* Louisiana, Dept. Cons., Geol. Bull., no. 7, 96 pp., 6 pls.

HUTCHISON, A. G., AND TERPSTRA, G. J. R.
1939 – *A note on the Biche Quarry limestone in Trinidad.* Amer. Assoc. Petr. Geol., Bull., vol. 13, no. 8, p. 1242 (abstract).

KEY [KEIJ], A. J.
1954 – *Ostracoda: Identification and description of species.* In: ANDEL, T. VAN, AND POSTMA, H., *Recent sediments of the Gulf of Paria (Reports of the Orinoco Shelf Expedition, Vol. 1).* K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, no. 5, pp. 218–229, pls. 3–6.

KINGMA, J. T.
1948 – *Contributions to the knowledge of the Young-Caenozoic Ostracoda from the Malayan region.* Utrecht, Univ., doct. diss., pp. 1–106, pls. 1–12, 3 text-figs., 1 chart.

LIENENKLAUS, E.
1894 – *Monographie der Ostracoden des nordwestdeutschen Tertiärs.* Deutsch. Geol. Ges., Zeitschr., vol. 46, pp. 158–268, pls. 13–18.

1896 – *Die Ostracoden aus dem Miozän von Ortenburg in Nieder-Bayern (Kollektion Egger).* K. Bayer. Akad. Wiss., Sitzber., vol. 26, pp. 183–207.

MALKIN, D. S.
1953 – *Biostratigraphic study of Miocene Ostracoda of New Jersey, Maryland and Virginia.* Jour. Pal., vol. 27, no. 6, pp. 761–799, pls. 78–82, text-figs. 1–14, tables 1–2.

MCLEAN, J. D., JR.
1957 – *The Ostracoda of the Yorktown formation in the York-James Peninsula of Virginia.* Bull. Amer. Pal., vol. 38, no. 167, pp. 57–96, pls. 7–12.

MÜLLER, G. W.
1894 – *Die Ostracoden des Golfes von Neapel und der angrenzenden Meeresabschnitten.* In: *Flora und Fauna des Golfes von Neapel, Monogr. 21.* Berlin: Zool. Stat. Neapel, pp. 1–404, pls. 1–40.

MÜNSTER, G. VON
1830 – *Über einige Arten von Cypris und Cythere.* Jahrb. Min., Geogn., Geol. und Petrefk., vol. 1, no. 1, pp. 60–67.

PURI, H. S.
1953*a* *Taxonomic comment on: "Ostracoda from wells in North Carolina; Part I – Cenozoic Ostracoda," by F. M. Swain.* Jour. Pal., vol. 27, pp. 750–752.

1953*b* *The ostracod genus Trachyleberis and its ally Actinocythereis.* Amer. Midland Nat., vol. 49, pp. 171–187.

1953*c* *Contribution to the study of the Miocene of the Florida Panhandle.* Florida, Geol. Survey, Bull., vol. 36, pp. 217–309, pls. 1–17.

RENZ, H. H.
1942 – *Stratigraphy of northern South America, Trinidad and Barbados.* Amer. Sci. Congr., 8th, Proc., vol. 4, pp. 513–517, 1 table.

1948 – *Stratigraphy and fauna of the Agua Salada group, State of Falcón, Venezuela.* Geol. Soc. Amer., Mem., no. 32, pp. 1–219, pls. 1–12.

RUGGIERI, G.
1950 – *Gli ostracodi delle sabbie grigie quaternarie (Milazziano) di Imola.* Giorn. Geol., ser. 2, vol. 21, pp. 1–57, pl. 1, text-figs. 1–34.

1952 – *Gli ostracodi delle sabbie grigie quaternarie (Milazziano) di Imola; II.* Giorn. Geol., ser. 2, vol. 22, pp. 59–115, pls. 1–8.

SEXTON, J. V.
1951 – *The ostracode Cytherelloidea in North America.* Jour. Pal., vol. 25, no. 6, pp. 808–816, pls. 115–117, 1 text-fig.

STEPHENSON, M. B.
1938 – *Miocene and Pliocene Ostracoda of the genus Cytheridea.* Jour. Pal., vol. 12, no. 2, pp. 127–148, pls. 23–24, text-figs. 1–20.

1943 – *Haplocytheridea bassleri, a new name for Cytheridea subovata Ulrich and Bassler.* Jour. Pal., vol. 17, no. 2, p. 206.

SUTER, H. H.
1954 – *The general and economic geology of Trinidad, B.W.I.* Great Britain, Colonial Geol. Survey, Colonial Geol. and Min. Res., vol. 2, nos. 3–4; vol. 3, no. 1.

SUTTON, A. H., AND WILLIAMS, J. B.
1939 – *Ostracoda from the Weches formation at Smithville.* Jour. Pal., vol. 13, no. 6, pp. 561–574, pls. 63–64.

1940 – *New names for Weches Ostracoda.* Jour. Pal., vol. 14, no. 2, p. 163.

SWAIN, F. M.
1948 – *Ostracoda from the Hammond well.* Maryland, Dept. Geol., Mines, and Water Resources, Bull., no. 2, pp. 178–213, pls. 12–14.

1951 – *Ostracoda from wells in North Carolina; Part I – Cenozoic Ostracoda.* U.S. Geol. Survey, Prof. Paper no. 234–A, pp. 1–58, pls. 1–7, text-figs. 1–3.

1955 – *Ostracoda of San Antonio Bay, Texas.* Jour. Pal., vol. 29, no. 4, pp. 561–646, pls. 59–64, text-figs. 1–39.

TRIEBEL, E.
1938 – *Ostracodenuntersuchungen; II – Die Cytheridea-Arten der Unteren Kreide.* Senckenbergiana, vol. 20, no. 6, pp. 471–501, pls. 1–6.

ULRICH, E. O., AND BASSLER, R. S.
1904 – *Ostracoda.* Maryland, Geol. Survey, Miocene, pp. 98–130, pls. 35–38.

WAGNER, C. W.
1957 – *Sur les ostracodes du Quaternaire récent des Pays-Bas et leur utilisation dans l'étude géologique des dépôts holocènes.* (Paris, Univ., Fac. Sci., Thèses, ser. A, no. 733). The Hague: Mouton & Co., pp. 3–260, pls. 1–50, text-figs. 1–26.

ZALANYI, B. T.
1944 – *Neogene Ostrakoden aus Ungarn.* Geol. Hungarica, Ser. Pal., fasc. 21, pp. 1–184.

ABSTRACT: *Three problematic microfossils from the Middle East are described as new*: Pseudovermiporella sodalica *from the Permian,* Aeolisaccus dunningtoni *from the Permian, Triassic, and Jurassic, and* Lacrymorphus perplexus *from the Triassic. It is suggested that* Aeolisaccus *may be a pteropod, and the other two algae.*

Fossil microproblematica from the Middle East

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INTRODUCTION

During studies of the fossil algal microfloras of the Middle East, carried out largely on thin sections, various problematic bodies, of undoubted organic origin but somewhat obscure affinities, have been noted at different horizons. The present paper describes three of these, from the Permian, Triassic, and Jurassic. All are named and their probable nature discussed; the uncertainties attaching to their classification do not, of course, affect their usefulness as indicators of the age of the rocks in which they occur.

My thanks are due to the Chief Geologist and Management of the Iraq Petroleum Company, Ltd., for permission to publish this paper, and to all those with whom these fossils have been discussed.

SYSTEMATIC DESCRIPTIONS

Genus **Pseudovermiporella** Elliott, **new genus**

Small gregarious meandriform calcareous tubes, showing a free inner thin compact-walled tube and an outer tubular layer that is pierced by numerous closely set radial pores arranged to form a regular mesh.

Type species: Pseudovermiporella sodalica Elliott, n. sp.; Permian of the Middle East. Possibly occurring also in the Tunisian and Japanese Permian.

Pseudovermiporella sodalica Elliott, **new species**

Plate 1, figures 1–6; plate 2, figures 2–6; plate 3, figures 1–4, 7

Description: Tubes of finely crystalline calcite, appearing white by reflected light and dark in thin section, occurring commonly with various diameters up to 1.0 mm. and sometimes attaining a diameter of 1.4 mm. The tubes are meandriform and form tangled growths several millimeters across, in which apparently more than one individual may occur. When a tube is free the cross section is circular, and remains approximately so in many coils or loops, which touch in a growth or tangle. However, individuals occur attached to others or to shell fragments, which show in thin section as arcs applied closely to the object encrusted, whose outer surface completes the tube (pl. 3, fig. 7).

The tubes are pierced by numerous closely set radial pores, approximately at right angles to the axis of the tube, separated by interpore wall material which widens slightly outward, or terminally, as seen in transverse and vertical sections. In adult individuals the pores are about 0.030–0.040 mm. in diameter, circular in cross section, about fifty to a transverse section of the tube, and the interpores of wall material sometimes show a paired appearance in both transverse and vertical section. In tangential sections the coarsely pored wall shows as a regular and distinctive round-pored mesh (pl. 2, fig. 6), with pores wider than interpores; a count along a 1 mm. length of such a section gave twenty-one regularly spaced pores. Such measurements are approximate only, due to the coiled tubes, which are at best only sinuous and never really straight. Smaller tubes show smaller pores.

Within the outer pored tube described above there occurs in a majority of specimens a continuous solid dark calcareous layer, attached to the inner surface of the outer mesh. In many specimens this layer is indistinguishable in colour and texture from the dark outer calcite mesh, and has the appearance of being part of the tube (pl. 2, fig. 5); in some it shows as a lighter, obscurely banded layer of variable thickness (pl. 1, fig. 2), eccentrically placed with regard to the

outer tube, i.e., much thicker on one side than on the other in transverse section; and sometimes it is absent (pl. 1, fig. 5). This layer is interpreted as a secondary deposit formed subsequent to the death of the tube-building organism, though not after burial, for occasional specimens show organisms attached to its inner surface. The reason for its occurrence is discussed below. Consideration of the algal dust infillings described in *Koninckopora* by Wood (1943) did not permit close comparison, but the observations of Johnson (1957, p. 181) are of interest.

Within some but not all specimens there occurs an innermost tube of thin dark imperforate calcite, roughly circular in cross section (pl. 1, fig. 1), and of considerably lesser diameter than the inner diameter of the outer tube from mesh to mesh. Sometimes this thin layer forms the inner boundary of the secondary layer mentioned above (pl. 2, fig. 4); sometimes it is seen "free" within the central cavity, filled with transparent calcite and separated by the same mineral from the outer pored tube or from the dark secondary lining calcite if present (pl. 1, fig. 1). When intact, it is not invariably central in position; not infrequently it is broken, and sometimes small organisms are seen attached to it (pl. 2, fig. 2). It is considered to be of organic origin, and its relation to the outer pored tubes is discussed below.

The smallest tubes show in section as bubble-like clusters, rather like the nucleoconchs of certain foraminifera (pl. 3, figs. 2, 4). Although some of the sections in such a cluster are a result of the plane of section cutting a meandriform tube more than once, it seems likely that more than one individual, budding from a centre, may sometimes be present. The walls of these tiny immature tubes are composed of the innermost thin dark organic calcite just described; only when they are larger does a pored outer tube, with proportionally small pores, appear. There is considerable variation between individuals in the diameter-size at which this occurs.

In sections of the mesh of adult individuals, small bubble-like sections of the inner layer of small, usually single individuals sometimes occur, suggesting attachment or budding (pl. 3, fig. 1). Small pored tubes occur within the tubular cavities of larger individuals, attached either to the inside of the main outer mesh (rarely to the secondary calcite lining this, if present; pl. 1, fig. 4) or to the outside of the inner, thin-walled tube (pl. 2, fig. 2). They are never found within the latter when it is unbroken.

Holotype: The specimen figured in plate 1, figure 1, from the Permian of Jebel Qamar, Oman, Arabia. Coll. Geol. Dept. Iraq Petroleum Company, London; reg. no. DM. 3359/A.

Paratypes: The specimens figured in plate 1, figures 3–4, 6; plate 2, figures 2, 5–6; plate 3, figures 1, 3–4, 7; same locality and horizon; same collection, nos. DM. 3359/A–D, F–K.

Other material: Numerous sections in Permian limestone from Jebel Qamar, Oman, associated with fragments of the alga *Epimastopora* and debris of fusulinids, brachiopods and echinoderms; this limestone with *Pseudovermiporella* occurs also as derived material in the Mesozoic of the same area. *Pseudovermiporella* also occurs rarely in the subsurface Upper Permian of the Alan well, Mosul Liwa, northern Iraq.

Other species: Vermiporella sp., from the Upper Permian of Tebega, Tunisia (kindly sent to the writer by Dr. J. Emberger of Algiers), and *Vermiporella? nipponica* Endo (1954, p. 191), from the Upper Permian of Japan, may be referable to *Pseudovermiporella*, as discussed below.

Discussion: This peculiar little fossil was shown to several specialists in different groups (various invertebrates, and calcareous algae), both fossil and Recent, at the British Museum of Natural History and elsewhere, and was rejected by them all. Particularly considered were the foraminifera, on account of the "nucleoconch" structures, but the tubes are quite unlike anything in this group; the Bryozoa, but the pores are too small for zooecia, and again the tubular structures are anomalous; and the serpulid worms. The latter group shows in certain Tertiary species a tube composed of two shell-layers, the inner one compact, the outer one with scattered pores (see Wrigley, 1951, p. 193); the meandrine form of the tubes and the mode of attachment to other objects, and the occasional growth of small tubes within empty larger ones, are also similar. However, nothing like the regular outer mesh of *Pseudovermiporella* is known in any worm tube, and the further recognition of the lining layer of calcite within the mesh as being secondary and not an organic structure made this identification untenable. A comparison of *Pseudovermiporella* with the worm-like hemichordate *Rhabdopleura* and its allies was also fruitless, for, apart from different wall structure, the solid chitinous "creeping stolon" of the latter organisms is very different from the inner organic tube.

The writer, to whom these specimens were shown as possible calcareous algae, discounted this identification because of the creeping habit and dark calcite structures. The creeping habit is very rare and the dark calcite structures are anomalous in dasyclads, the tubular green algae which allow comparison. This identification was also rejected by the writer because of the continuous inner structures, for in dasyclads, the pores of the calcareous crusting tube are occupied in life by living branches from the main central stem. When exceptionally a second, inner tube exists, as in the Eocene *Neomeris (Vaginopora) fragilis* (Defrance), it is also pored (Morellet, 1913). No satisfactory explanation could be devised to account for the constant association of the various inner structures described with empty dasyclad tubes, if the outer-meshed tubes were regarded as such, and the inner structures regarded as remains of some other organism.

When, later, Endo's figures of *Vermiporella? nipponica* were seen (Endo, 1954, pl. 13), the similarities with the

Oman material were obvious. This Japanese Upper Permian species is smaller and has fewer pores, which, however, are similar in size, and form a similar mesh; the random sections figured appear similar to sections of *Pseudovermiporella*, but details of internal structures are not visible, and they are not mentioned in the description. Endo's species was described as a dasyclad, and referred doubtfully to *Vermiporella* because of various obscurities connected with earlier descriptions of *Vermiporella* species.

Vermiporella fragilis, the type species (Stolley, 1893) was described from the Baltic Silurian. Stolley's sketch-figures show a simple tubular structure, perforated by many pores. This organism appears thinner-walled and with proportionally finer and more widely spaced pores than in *Pseudovermiporella*; it was apparently crooked and branching, very fragile, and occurred fossil in broken pieces.

Discussed together with other primitive calcareous algae by Pia (1920, 1927), who referred Schubert's Permian *Stolleyella velebitana* to the genus, *Vermiporella* was next figured from the Silurian by Eisenack (1936), who freed silicified individuals from the matrix by acid treatment. These show *Vermiporella* as highly branched (about every 1 mm. of length) and anastomosing to give an angular three-dimensional mesh of the pored tubes; these tangles or thalli were about 20 mm. across.

Vermiporella velebitana (Schubert), from the Austrian and Balkan Permian, has been figured or recorded by Schubert (1908), Pia (1920), Ogilvie-Gordon (1927), Koch (1933), Simic (1933), and others. None of these figures is very clear, and it is evident that there has been considerable confusion over the determination of this species, as commented on by Pia (1937, p. 821). The best figure of a Permian *Vermiporella* is that of Pia's *Vermiporella sumatrana*, an Indonesian species (Pia, 1937, pl. 93). This shows a sinuous pored tube comparable with the Silurian *Vermiporella* already discussed.

Finally, the writer has had the opportunity of examining a *Vermiporella* sp. from the Upper Permian of Tunisia (pl. 2, fig. 1). This is not as clearly preserved as the Oman material, and apparently does not show inner tubes, though certain other internal aspects of preservation are similar. However, it is of great interest as showing the organism growing into and spreading within a hollow empty bead-like unit of the alga *Mizzia*; this point is further discussed below.

With these comparisons in mind, the following tentative explanation of *Pseudovermiporella* is offered. It is considered to be a very primitive dasyclad alga, like *Vermiporella*. The latter differs from most other dasyclads in its irregular, sinuous, branching tube, the standard pattern for the family being straight, single and vertical in growth. Where the creeping plant stem crossed a foreign body and grew against it, there was complete or partial failure of calcareous secretion due to the absence of photosynthesis. Small internal *Pseudovermiporella* within larger empty pored tubes, sometimes growing on the inner imperforate tube (never in it), apparently found sufficient light for growth; the Tunisian *Vermiporella* spreading within the coarsely-pored hollow *Mizzia* unit (pl. 2, fig. 1) is a useful check on this point. A relatively dim submarine illumination is normal, and *Pseudovermiporella* grew in very shallow water, probably on a white limy bottom, as indicated by the limestone facies in which it occurs.

A germinating spore of *Pseudovermiporella* would give rise to a simple, prone main green stem, probably with scattered side-branches only. The appearance of early budding described above might be due to two or more attached spores germinating together, or to two or more initial stems forming. The early stem would not be calcified, as is also the case in the development of Recent dasyclads (see Church, 1895). As the stem grew, probably rapidly, as in other creeping plants, the earlier side-branches dropped off, and this early portion of the stem-cell became calcified, forming the inner tube. A zone of calcification also appeared on the later-formed side-branches at some distance from the central stem, possibly with the achievement of sexual maturity, as occurs in many other dasyclads of more normal morphology, and so formed the larger, outer pored tube. As the plant grew, the two tubes were developed *pari passu*. The little sections of the inner tube seen in the mesh of the pored tube in larger individuals may indicate chance attachment and germination of spores on the outside of adults, or possibly some form of budding. If the latter, a connexion should be visible with the inner tube, but this has not been seen with certainty in the sections available. Only one somewhat doubtful example of the main inner tube branching into two has been noted.

The small pored tubes seen within larger tubes, variously attached, are considered to represent post-mortem colonisation; the question of light-intensity for photosynthesis has already been mentioned. Similarly, the frequent growth of thick secondary calcite between inner and outer tubes, and the frequent broken or misplaced inner tube, would be not unlikely post-mortem changes to such a double tubular structure.

It must be placed on record that the calcite of these tubes, appearing dark in thin section, is anomalous for dasyclads, which are initially largely aragonitic and appear light, with dark infillings of pores, in most fossils. The associated alga *Epimastopora*, in the *Pseudovermiporella* limestone itself, is thus preserved. However, Endo's figures of *Vermiporella? nipponica* appear to show both forms of preservation. The present writer is disinclined to be dogmatic about calcium carbonate structures in a Palaeozoic limestone from a tectonically complex area.

It cannot be claimed that the hypothesis above definitely proves the algal nature of *Pseudovermiporella*, but it does take into account the undoubted resemblance to the alga *Vermiporella*, while explaining the varied and puz-

zling phenomena seen in sections of different growth stages. Moreover, the growth habit suggested is one not uncommon in the plant world, and dasyclad algae are primitive plants, of which it is generally agreed that living examples are scattered survivors of a much more numerous and varied assemblage now extinct.

The generic name commemorates the resemblance of the organism to *Vermiporella*, the specific name the gregarious occurrence.

Genus **Aeolisaccus** Elliott, **new genus**

Small hollow thin-walled calcareous tubes, gently tapering, open at both ends, the long axis slightly irregular or gently curved, walls irregularly annular.

Type species: Aeolisaccus dunningtoni Elliott, n. sp.; Permian, Upper Triassic, and Lower to Middle Jurassic of the Middle East.

Aeolisaccus dunningtoni Elliott, **new species**
Plate 3, figures 5–6, 8–9

Description: Small hollow thin-walled tubes with wall structure of crystalline calcite, about 0.010 mm. thick; maximum length observed 1.716 mm., but they are often broken; corresponding maximum diameter observed 0.130 mm., but commonly 0.100 mm. or a little less. In shape they are gently tapering tubes, slightly curved or irregular, the maximum diameters normally terminal but sometimes subterminal. Highly oblique sections through the walls show crowded transverse lines which suggest a septate or camerate structure, but this is never substantiated by true vertical sections, and is due merely to the annular wall-form. In one long, irregular example, the plane of section twice cuts the shell obliquely and shows these lines each time. Similarly, the numerous off-vertical sections which suggest a closed, acuminate apex are not confirmed by true vertical sections, and it would seem that the tube is open at both ends, though some such vertical sections are of broken specimens. The wall structure of these tubes is identical with those of occasional associated small foraminifera as preserved in the same sections.

Holotype: The specimen figured in plate 3, figure 8, from the Upper Permian limestone of Harur, Mosul Liwa, northern Iraq; reg. no. Wl. 11365.

Paratypes: Numerous random sections in the same slide as that showing the holotype.

Other material: Specimens from Fahud well, Oman, Arabia; subsurface horizon, probably topmost Permian. Specimens from the Upper Triassic of Argosh, Mosul Liwa, and subsurface Upper Triassic of Qalian well, Mosul Liwa. Numerous specimens from the subsurface Jurassic, mostly Lower, sometimes Middle, of the deep wells of the Mosul area, northern Iraq.

Discussion: This curious little protean tube affords few clues to the nature of the organism which occasioned it. Among comparable fossil tubes, the organism described by Valensi (1953, p. 64) from the Middle Jurassic is not really similar, considering the few characters available. It shows a distinctive wall structure, and is only 0.042 by 0.023 mm. in size. The doubtful *Calcinema triasinum* Bornemann from the German Trias, a small smooth thin-walled tube of near-circular cross section, straight or curved, of 0.10 mm. diameter and 1.0 mm. length, was described as an alga (Bornemann, 1886, p. 290), queried by Frantzen (1888, p. 86), and finally listed as doubtful by Pia (1927). It is recognisably different from *Aeolisaccus*.

PLATE 1

All figures are of thin sections of *Pseudovermiporella sodalica* Elliott, n. sp., from the Permian limestone of Jebel Qamar, Oman, Arabia; × 50.

1 Holotype; meandriform cluster showing coarse outer organic mesh, secondary incrustation within, and thin inner organic tube within innermost clear calcite filling. Reg. no. DM. 3359/A, Coll. Geological Department, Iraq Petroleum Co. Ltd., London.

2 Specimen showing outer mesh lined by obvious banded secondary incrustation. Reg. no. DM. 3359/G.

3 Typical cluster with secondary lining calcite indistinguishable from calcite of outer organic mesh. Reg. no. DM. 3359/K.

4 Specimen in which a small meshed individual is seen attached to the secondary lining calcite of the larger individual. Reg. no. DM. 3359/C.

5 Specimen without definite lining layer of secondary calcite. Reg. no. DM. 3359/A.

6 Approximately longitudinal section of large, coarse-meshed individual. Reg. no. DM. 3359/H.


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The small size and few associated tiny foraminifera suggest that *Aeolisaccus* was a pelagic organism. Pelagic worms are not normally tubed, and one example suggested to the writer, a delayed-settlement phenomenon, is arenaceous in structure, not calcareous. It is therefore suggested that these fossils are the shells of a small extinct pteropod species. These tiny, highly modified, pelagic mollusks apparently occur as fossils from the Palaeozoic on; even if the earlier fossils are not directly ancestral, they are in many respects similar to the modern shells. Recent pteropods are larger than the Middle Eastern fossils (3–5 mm. long), but often show a similar pattern of very fine lines on the very thin shell, and some are tubular. In the somewhat similar Caecidae, classified with the true gastropods, an initial spire is shed and the resulting open narrow end of the tube is periodically closed by a thin septum. Finally, figures of an alleged pteropod from the European Devonian (Cuvillier, 1956, pl. 1) show elongate cores which widen more rapidly and regularly than *Aeolisaccus* but come within the same approximate size-range (0.32–0.64 mm. long by 0.09–0.018 mm. in diameter).

This fossil is named from its resemblance to a tiny aeronautical wind-indicator, and is dedicated to Mr. H. V. Dunnington of Kirkuk, who early noted it in studies of the subsurface Jurassic of northern Iraq, and to whom I am indebted for numerous thin sections of interesting fossil calcareous algae.

Genus **Lacrymorphus** Elliott, **new genus**

Tiny spherical, pear-, acorn-, or retort-shaped thin-walled hollow bodies, occurring in clusters.

Type species: Lacrymorphus perplexus Elliott, n. sp.; Upper Triassic of northern Iraq.

Lacrymorphus perplexus Elliott, **new species**
Plate 3, figures 10–11

Description: These little bodies occur within ooliths, in a brown phosphatic rock composed of normal concentric ooliths, the fossiliferous ooliths, worn shell fragments, and rounded and coated rock fragments of oolith size. In section, the fossils show as circles of the order of 0.065–0.080 mm. diameter, very thin-walled, and closely but irregularly set, often nearly touching but never with polygonal outline. Occasionally a small area of stained calcitic matrix is seen between adjacent clusters. When well preserved they show clear calcite filling, with calcite interstices lightly stained. The circles are not sections of tubes, for of many ooliths examined not one showed longitudinal cuts. However, they are not all spheres, for, not uncommonly, random cuts show rounded elongate prolongations or projections of the outline, indicating pear, acorn, or retort shapes.

Holotype: The cluster figured in plate 3, figure 10, from the Upper Triassic limestone of Ora, Mosul Liwa, northern Iraq; reg. no. Wl. 8618.

Paratype: A second cluster in the same thin section as that containing the holotype.

Other material: Other thin sections from the same bed.

Discussion: These organisms have not been seen in various illustrated works on the microfaunas of the Old World Trias, in which the most similar thing observed was the somewhat obscure little problematicum Pm_8 of Wirz (1945, p. 58), recorded from the Swiss Ladinian. It is of course possible that the ooliths are from a rock older than Triassic. The organisms have not been recognised by the writer and others as portions of Hydrozoa, Bryozoa, or other simple colonial organisms, nor as parts of non-unicellular algae. Derville (1931, pl. 18) figured

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PLATE 2

All figures except figure 1 are of thin sections of *Pseudovermiporella sodalica* Elliott, n. sp., from the Permian limestone of Jebel Qamar, Oman, Arabia; × 50.

1 *Vermiporella* sp. (*Pseudovermiporella?* sp.), Upper Permian, Jebel Tebaga, Tunisia; × 50. Growth around a coarsely pored unit of the alga *Mizzia*; the *Vermiporella* has grown through one pore and spread inside. Reg. no. TBC. 1.

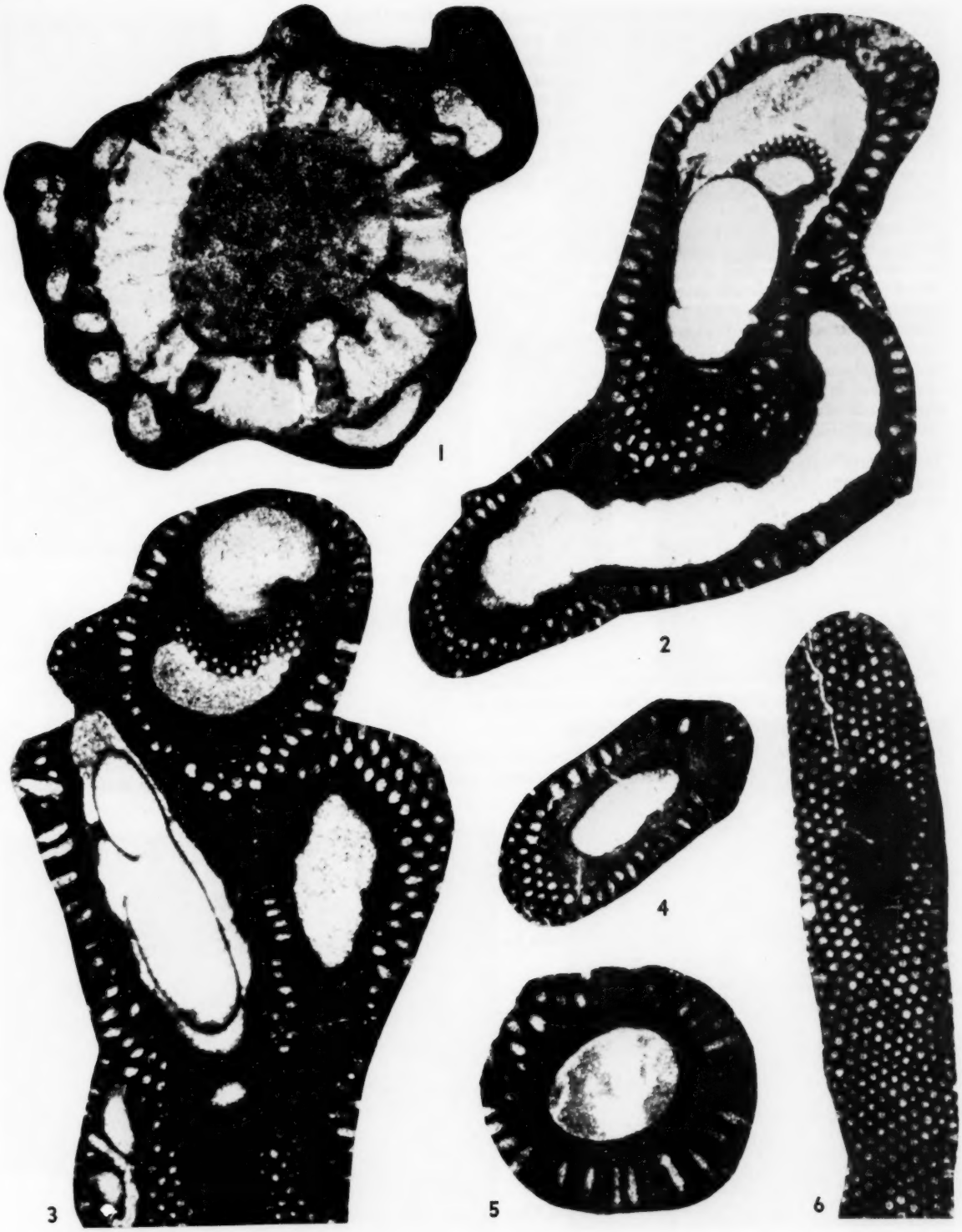
2 A large individual within which a small meshed individual has grown on the inner tube. Reg. no. DM. 3359/H.

3 Specimen showing organic mesh, lining calcite, inner organic tube, and a small individual within a larger tube. Reg. no. DM. 3359/H.

4 Specimen in which the secondary calcite fills the space between mesh and inner tube completely. Reg. no. DM. 3359/H.

5 Specimen in which secondary calcite and calcite of outer mesh are indistinguishable. Reg. no. DM. 3359/D.

6 Tangential section to show coarse mesh. Reg. no. DM. 3359/K.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various spheres (*Cytosphaera*, etc.) from the French Lower Carboniferous; these are single bodies, larger (0.100 mm. and upward), with thicker walls showing finely granular wall structure with traces of radial and concentric structures. Derville was uncertain of the origin of these bodies, but inclined toward an algal origin for some. Certain peculiar little unicellular bodies of the same size-order known to the writer from the English Lower Carboniferous are also different from *Lacrymorphus*.

The aggregation of these clustered cells may be fortuitous, but such clustering seems to be the rule. Consideration of the interesting sponge embryos figured by Wood (1946) did not permit close comparison. It is now suggested that *Lacrymorphus* is the fossil indication of clusters of unicellular green algae, such as exist today. Such pyriform cells could have been terminally flagellate, and bunched together by their flagellae; during mineralisation the thin outer organic cell-membrane would have acted as a dividing surface for differential calcite crystallisation.

The generic name refers to the outline of the simple bodies; the specific name to the uncertainty which attaches to them.

BIBLIOGRAPHY

BORNEMANN, J. G.
1886 – *Beiträge zur Kenntniss des Muschelkalks, insbesondere der Schichtenfolge und der Gesteine des unteren Muschelkalks in Thüringen.* Preuss. Geol. Landesanst., Jahrb. (1885), pp. 267–321, pls. 7–14.

CHURCH, A. H.
1895 – *The structure of the thallus of Neomeris dumetosa, Lamour.* Ann. Bot., vol. 9, pp. 581–608, pls. 21–23.

CUVILLIER, J.
1956 – *Stratigraphic correlations by microfacies in western Aquitaine.* Ed. 2. Leiden: E. J. Brill, pp. 1–33, pls. 1–100.

DERVILLE, H.
1931 – *Les marbres du calcaire carbonifère en Bas-Boulonnais, Strasbourg.* Strasbourg, Univ., Fac. Sci., Thèses, ser. E, no. 29, pp. 1–322, pls. 1–24.

EISENACK, A.
1936 – *Die Form der Thallus der Siphonee Vermiporella.* Zeitschr. Geschiebef., vol. 12, pp. 184–186, text-figs. 1–4.

ENDO, R.
1954 – *Stratigraphical and paleontological studies of the later Paleozoic calcareous algae in Japan, no. 7; Pt. 2 — Description of the algal remains.* Saitama Univ., Sci. Repts., ser. B, vol. 1, pp. 190–208, pls. 13–17.

PLATE 3

1 *Pseudovermiporella sodalica* Elliott, n. sp.
Transverse section of a small individual with second attached or budding individual in outer mesh; × 50. Permian limestone, Jebel Qamar, Oman, Arabia; reg. no. DM. 3359/F.

2–4 *Pseudovermiporella sodalica* Elliott, n. sp.
Sections of small early clusters or "nucleoconch" structures; × 50. In figure 3 the central, clear calcite-filled, reniform section is unusually large but is apparently that of an early "inner tube." Same locality and horizon as fig. 1; reg. nos. DM. 3359/B, J, G.

5 *Aeolisaccus dunningtoni* Elliott, n. sp.
Approximately longitudinal section of irregular elongate tube, showing annular structure where the plane of section is tangential within the wall structure; × 50. Subsurface uppermost Permian, Fahud well, Oman, Arabia; reg. no. FD. 828.

6 *Aeolisaccus dunningtoni* Elliott, n. sp.
Longitudinal section; × 50. Subsurface Lower Jurassic, Mileh Thartar well, Dulaim Liwa, northern Iraq; reg. no. MT. 727.

7 *Pseudovermiporella sodalica* Elliott, n. sp.
Section of individual attached to brachiopod shell; × 50. Permian limestone, Jebel Qamar, Oman, Arabia; reg. no. DM. 3359/J.

8 *Aeolisaccus dunningtoni* Elliott, n. sp.
Holotype; × 50. Upper Permian limestone of Harur, Mosul Liwa, northern Iraq; reg. no. Wl. 11365.

9 *Aeolisaccus dunningtoni* Elliott, n. sp.
Section showing numerous individuals; × 50. Subsurface uppermost Permian, Fahud well, Oman, Arabia; reg. no. FD. 828.

10 *Lacrymorphus perplexus* Elliott, n. sp.
Holotype; × 145. Upper Triassic limestone, Ora, Mosul Liwa, northern Iraq; reg. no. Wl. 8618.

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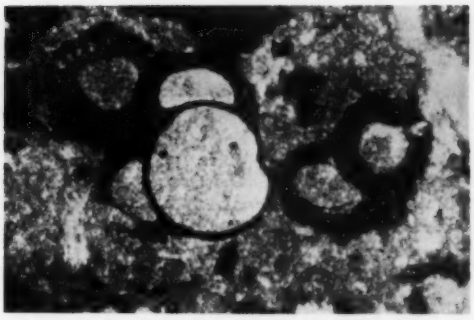

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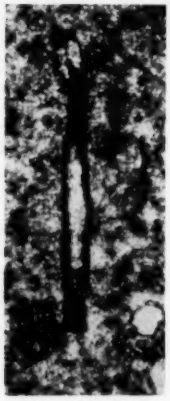

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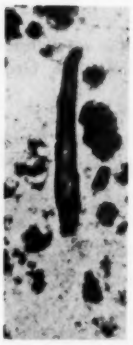

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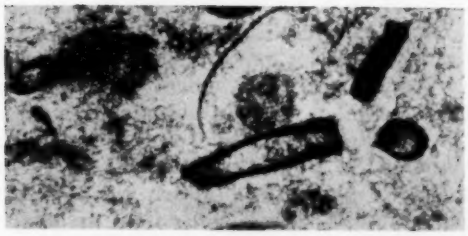

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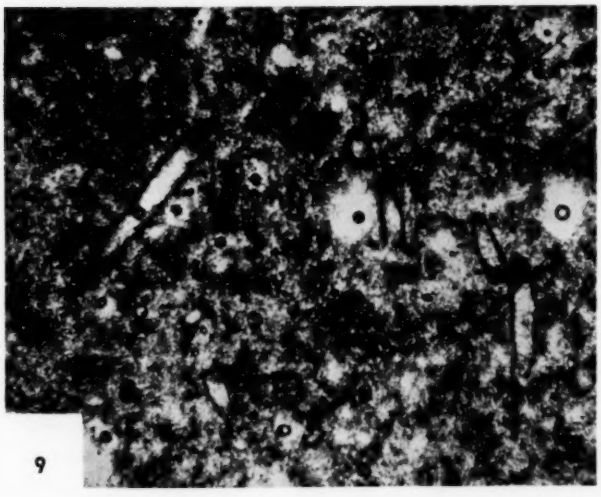

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FRANTZEN, W.
1888 – *Untersuchungen über die Gliederung des unteren Muschelkalks in einem Theile von Thüringen und Hessen und über die Natur der Oolithkörner in diesen Gebirgsschichten.* Preuss. Geol. Landesanst., Jahrb. (1887), pp. 1–93, pls. 1–3.

JOHNSON, J. H.
1957 – *Petrography of the limestones.* In: *Geology of Saipan, Mariana Islands.* U. S. Geol. Survey, Prof. Paper no. 280-C.

KOCH, F.
1933 – *Beitrag zur Geologie von Montenegro.* Belgrade, Geol. Inst. Kral. Jugoslav, Vesn., vol. 2, pp. 3–39, pls. 1–13.

MORELLET, L., AND MORELLET, J.
1913 – *Les dasycladacées du Tertiaire Parisien.* Soc. Géol. France, Mém., Ser. Pal., no. 47.

OGILVIE-GORDON, M. M.
1927 – *Das Grödener-, Fassa- und Enneberggebiet in den südtiroler Dolomiten; Teil III — Paläontologie.* Austria, Geol. Bundesanst., Abh., vol. 24, no. 2.

PIA, J.
1920 – *Die Siphoneae Verticillatae vom Karbon bis zur Kreide.* Zool.-Bot. Ges. Wien, Abh., vol. 11, no. 2, pp. 1–263, pls. 1–7.

1927 – *Thallophyta.* In: HIRMER, M., *Handbuch der Paläobotanik.* Munich and Berlin.

1937 – *Die wichtigsten Kalkalgen des Jungpaläozoikums und ihre geologische Bedeutung.* Congr. Avanc. Étude Strat. Carb., 2nd (Heerlen, 1935), C. R., vol. 2, pp. 765–856, pls. 85–97.

SCHUBERT, R J.
1908 – *Zur Geologie des österreichischen Velebit (nebst paläontologischem Anhang).* K. K. Geol. Reichsanst., Jahrb., vol. 58, pp. 345–386, pl. 16.

SIMIC, V.
1933 – *Das Oberperm in Westserbien.* Belgrade, Geol. Inst. Kral. Jugoslav, Rasp., vol. 1, 130 pp., 10 pls.

STOLLEY, E.
1893 – *Über silurische Siphoneen.* Neues Jahrb. Min. Geol. Pal., pt. 2, pp. 135–146, pls. 7–8.

VALENSI, L.
1953 – *Microfossiles des silex du Jurassique moyen; Remarques pétrographiques.* Soc. Géol. France, Mém., new ser., no. 68.

WIRZ, A.
1945 – *Beiträge zur Kenntnis des Ladinikums im Gebiete des Monte San Giorgio.* Schweiz. Pal. Abh., vol. 65, no. 2, 84 pp., 3 pls.

WOOD, A.
1943 – *The algal nature of the genus Koninckopora Lee; its occurrence in Canada and western Europe.* Geol. Soc. London, Quart. Jour., vol. 98, pp. 205–222, pls. 8–10.

1946 – *Probable sponge embryos in a rock of Arenig age.* Geol. Assoc. London, Proc., vol. 57, pp. 19–21, pl. 3.

WRIGLEY, A.
1951 – *Some Eocene serpulids.* Geol. Assoc. London Proc., vol. 62, pp. 172–202, text-figs. 1–66.

"Microforaminifera" from Pleistocene deposits, Prince Edward Island, Canada

JAAN TERASMAE
Geological Survey of Canada
Ottawa, Ontario

Microscopic examination of post-glacial sediments from Nicholas Point, southeastern Prince Edward Island, Canada, collected by V. K. Prest and L. Frankel for the Geological Survey of Canada, showed the presence of abundant "microforaminifera" in several samples (pl. 1). Besides marine diatoms, the samples contained abundant finely disseminated plant detritus, fungus remains, pollen grains, and spores. The samples were of marine silt and silty clay deposited in shallow water, as indicated by the transition from marine silty clay to fresh-water peat. As the samples were treated with hydrochloric acid and hydrofluoric acid, as well as by the acetolysis method, it was naturally surprising to find small foraminifera in the final slides. However, similar discoveries had been made by van Veen (1957), who examined Recent marine bottom-samples from the South China Sea, and by Wilson and Hoffmeister (1952), who studied samples of Tertiary shales. Several references to the subject are given by Wetzel (1957).

Hoffmeister (1955) suggested that the presence of an acid-resistant (chitinous?) inner coat prevented disintegration of the originally calcareous or arenaceous tests of these foraminifera during treatment with hydrochloric and hydrofluoric acids (see also van Veen, 1957). Grayson (1956) suggested that conversion of calcite to fluorite prevents disintegration during standard hydrofluoric acid treatment. This statement by Grayson is subject to criticism, as pointed out by Wetzel (1957), because these foraminifera are nevertheless present even when the sample has been treated with hydrochloric acid first. Wetzel (1957) has suggested that pseudomorphous transformation of these microfossils, whose cavities or walls were previously filled diagenetically with siliceous, pyritic or other mineral matter, may explain their unusual resistance to acids.

The writer is convinced that the chemical composition of these "microforaminifera" is similar to that of pollen and spore exines and some fungus structures. He suggests that the resistance to acids and other chemicals commonly used in the study of pollen grains and spores is due to the (chitinous?) character of certain membranes or inner linings of individual chambers of these "microforaminifera." However, the larger foraminifera that are also present in the original samples were apparently absent in the final residue.

BIBLIOGRAPHY

GRAYSON, J. F.
1956 – *The conversion of calcite to fluorite.* Micropaleontology, vol. 2, no. 1, pp. 71–78.

HOFFMEISTER, W. S.
1955 – *Microfossils provide new technique in exploration.* World Oil, vol. 140, no. 5, pp. 156–158.

VEEN, F. R. VAN
1957 – *Microforaminifera,* Micropaleontology, vol. 3, no. 1, p. 74.

WETZEL, O.
1957 – *Fossil "microforaminifera" in various sediments and their reaction to acid treatment.* Micropaleontology, vol. 3, no. 1, pp. 61–64.

WILSON, L. R., AND HOFFMEISTER, W. S.
1952 – *Small foraminifera.* The Micropaleontologist, vol. 6, no. 2, pp. 26–28.

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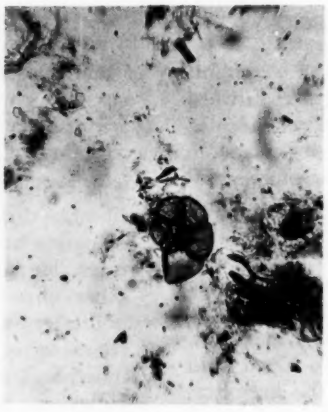
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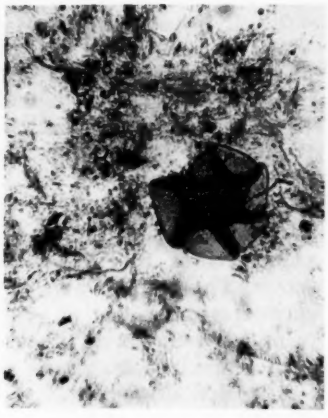
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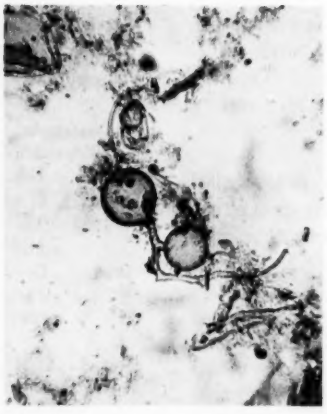
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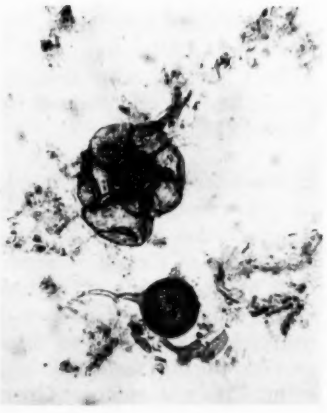
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1–6, details of individual "microforaminifera"; the size of the "microforaminifera" in the examined slides ranges in general from 50 to 200μ; in fig. 3 a pine pollen grain is shown in the upper right corner; 7–9, details of fungus in the same slides. All figures are of the same magnification.

ABSTRACT: *One hundred and one papers on all aspects of micropaleontology are listed and briefly reviewed.*

Annotated bibliography of micropaleontology in Germany for 1957

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Amt für Bodenforschung
Hannover

This is a continuation of the bibliography published last year in MICROPALEONTOLOGY (1957, vol. 3, no. 4, pp. 399–406). As before, it is again restricted to papers that are concerned with micropaleontology and microstratigraphy or that mention microscopic fossils. In addition to foraminifera, this bibliography covers ostracodes, Radiolaria, and other animal microfossils, as well as microscopic fragments of larger organisms and fossil plant remains. Papers that are important in taxonomy are marked with an asterisk.

BARTENSTEIN, H.

1957 – *Carl A. Wicher—1901–1957.* Micropaleontology, vol. 3, no. 3, p. 268, 1 portr.

A brief notice concerning this eminent research worker and his activities in stratigraphic micropaleontology.

1957 – *Ein bisher unbekanntes Tertiär-Vorkommen (Mittel-Oligozän) auf Meßtischblatt Lauenau (3722).* Geol. Jahrb., vol. 73, pp. 295–300, 2 text-figs.

Description of a glauconitic marly clay and determination of its age as Middle Oligocene, on the basis of foraminifera.

BARTENSTEIN, H., BETTENSTAEDT, F., AND BOLLI, H. M.

*1957 – *Die Foraminiferen der Unterkreide von Trinidad, B.W.I.; Teil 1 – Luche and Toco-Formation.* Eclogae Geol. Helv., vol. 50, pp. 5–67, 8 pls., 3 text-figs.

The benthonic foraminifera of the Luche and Toco formations are described. Among the thirty-nine genera, comprising ninety species and subspecies (nine of which are new), there are twenty-one agglutinated, fifty-four Lagenidae, and fifteen other calcareous forms. On the basis of *Globorotalites bartensteinii intercedens* and *Vaginulina procera*, and five forms restricted to the Barremian, the age of nine samples from six Trinidad localities can be determined.

BETTENSTAEDT, F.

1957 – *Mikropaläontologische und stratigraphische Untersuchungen im Helvetikum und Flysch der Bayerischen und Vorarlberger Alpen und einige tektonische Folgerungen.* Pal. Zeitschr., vol. 31, p. 7. (Abstract.)

Micropaleontology and age of the "Leitmergel," "Drusberg-" and "Wangschichten," as well as of various horizons of the Flysch, and discussion of tectonic implications.

BHARDWAJ, D. C.

*1957 – *The spore flora of Velener Schichten (Lower Westphalian D) in the Ruhr Coal Measures.* Palaeontographica, vol. 102, pt. B, pp. 110–138.

Morphologic and nomenclatural discussion; description and floristic stratigraphy of sixty-six miospores and megaspores, among them thirteen new species.

BISCHOFF, G.

*1957 – *Die Conodonten-Stratigraphie des rheno-herzynischen Unter-Karbons mit Berücksichtigung der Wocklumeria-Stufe und der Devon-Karbon-Grenze.* Hessen, Landesamt Bodenf., Abh., vol. 19, 64 pp., 1 text-fig., 2 tables, 6 pls.

Description and distribution of twenty-five genera of conodonts, among them *Mestognathus*, n. gen., comprising ninety-four species (seven of which are new) and six subspecies from the *Wocklumeria*, *Gattendorfia*, *Pericyclus*, and *Goniatites* stages. Vertical ranges of fourteen index conodonts in the Upper Devonian and Lower Carboniferous.

BISCHOFF, G., AND STOPPEL, D.

1957 – *Zum Alter des Wollenberg-Kellerwald-Quarzits (Rheinisches Schiefergebirge).* Neues Jahrb. Geol. Pal., Monatshefte, pp. 14–24, 4 text-figs.

Discovery of fourteen conodonts, of which *Scagliognathus auchoralis* is figured. On the basis of this species, the Scheffelborner beds are of Kulm II age.

BISCHOFF, G., AND ZIEGLER, W.
1957 – *Die Conodontenchronologie des Mitteldevons und des tiefsten Oberdevons.* Hessen, Landesamt Bodenf., Abh., vol. 22, 136 pp., 16 text-figs., 21 pls., 5 tables.

Description and illustration of 155 conodonts, among which thirty-four species are new. Their use as index fossils, and their occurrence in eleven different beds of the Eifelian, Givetian and Manticoceras stages.

BRELIE, G. VON DER, AND TEICHMÜLLER, R.
1957 – *Das gefaltete "Eozän" des Antweiler Grabens am N-Abfall der Eifel.* Neues Jahrb. Geol. Pal., Monatshefte, pp. 108–112, 2 text-figs.

Note on the Paleocene-Eocene age of two dark clay beds, with a list of sixteen sporomorphs.

BROSIUS, M., AND GRAMANN, F.
1957 – *Eine Oligozänbohrung im südlichen Habichtswald bei Kassel.* Hessen, Landesamt Bodenf., Notizbl., vol. 85, pp. 206–217, 2 text-figs.

Petrography and fossils of a boring penetrating 37 meters of Chattian and 33 meters of Rupelian; the lists contain some names of foraminifera.

DANISCH, E.
1957 – *Beitrag zur Stratigraphie des Doggers am Voßberge südlich Engters (Wiehengebirge).* Naturw. Ver. Osnabrück, Veröff., vol. 28, pp. 41–49, 1 table.

List of names of twenty foraminifera and other microfossils from the Dogger beta and gamma.

DIEBEL, K.
1957 – *Jüngste mesozoische Conodonten.* Pal. Zeitschr., vol. 31, pp. 6–7.

Abstract of "Conodonts in the Upper Cretaceous of Kamerun" (Geologie, vol. 5, Berlin, 1956).

DIJKSTRA, S. J.
1957 – *Über unterkarbonische Megasporen.* Pal. Zeitschr., vol. 31, pp. 7–8. (Abstract.)

A stratigraphic comparison of megaspores from Egypt and Scotland.

EISENACK, A.
*1956 – *Probleme der Vermehrung und des Lebensraumes der Gattung Leiosphaera (Hystrichosphaeridea).* Neues Jahrb. Geol. Pal., Abh., vol. 102, pp. 402–408, 2 text-figs.

New observations and interpretations of cutin holes closed by lids (= "pylome"), interior balls, and thick membranes of these small fossils.

*1957 – *Mikrofossilien in organischer Substanz aus dem Lias Schwabens (Süddeutschland).* Neues Jahrb. Geol. Pal., Abh., vol. 105, pp. 239–249, 2 pls., 2 text-figs.

Treatment of Liassic shales with HCl and other inorganic acids. The small balls of cutin thus recovered are assigned as species to *Tasmanites, Tytthodiscus, Cymatiosphaera,* and *Leiosphaeridia,* all of which are thought to be Hystrichosphaeridea.

FALKE, H.
1957 – *Zur Geologie der Umgebung von Stromberg.* Hessen, Landesamt Bodenf., Notizbl., vol. 85, pp. 75–113, 7 text-figs., 5 pls.

References to Devonian conodonts identified by G. Bischoff.

FLÜGEL, H., AND ZIEGLER, W.
*1957 – *Die Gliederung des Oberdevons und Unterkarbons am Steinberg westlich von Graz mit Conodonten.* Naturwiss. Ver. Steiermark, Mitt., vol. 87, pp. 25–60, 5 pls., 6 text-figs.

Fifty samples from a 130-meter section of the "Steinberg-Kalke" are classified as Upper Devonian and Lower Carboniferous according to the German chronology of conodonts. Descriptions and illustrations of forty-five conodonts, among which two species are new. Comparative tables covering 108 conodonts, sixty-five of which are useful in subdividing the Upper Devonian into four stages. The "Visé-Kalk" is called the "Gnathodus-Kalk."

GERTH, H.
1957 – *Das Vorkommen von permokarbonischen Fusulinenkalken im Westpatagonischen Archipel und seine paläogeographische und paläoklimatische Bedeutung.* Deutsch. Geol. Ges., Zeitschr., vol. 109, pp. 193–198, 1 text-fig.

References to the occurrence of limestone with fusulines, and the general conclusions that can be derived from them.

GOCHT, H.
*1957 – *Mikroplankton aus dem NW-deutschen Neokom.* Pal. Zeitschr., vol. 31, pp. 163–185, 16 text-figs., 3 pls.

Description and classification of 197 different organic balls resembling dinoflagellates; forty-six are figured; one new genus is established, *Pseudoceratium,* with two new species; *Wetzeliella neocomica,* n. sp., with six new formae, is also established; all from ten samples of Valanginian, Hauterivian and Barremian age.

GOCHT, H., AND GOERLICH, F.
*1957 – *Reste des Chitin-Skelettes in fossilen Ostracoden-Gehäusen.* Geol. Jahrb., vol. 73, pp. 205–214, 1 pl., 3 text-figs.

By dissolving the carapaces of Mesozoic Ostracoda in HCl, it has become possible to recover the remains of the antennae, legs, and other parts of the chitinous skeleton of the animal

GREBE, H.

1957 – *Zur Mikroflora des niederrheinischen Zechsteins.* Deutsch. Geol. Ges., Zeitschr., vol. 108, pp. 258–259.

The microflora is poor in species but well preserved; 90 per cent of them belong to the genera *Lueckisporites*, *Pityosporites* and *Jugasporites*; some layers of clay contain up to 30,000 spores in one cc.

GREILING, L.

1957 – *Der Kalk der Löhmar-Mühle (Gotlandium, Frankenwald).* Senckenbergiana Lethaea, vol. 38, pp. 251–259, 2 text-figs.

Identification of some graptolites and ostracodes, resulting in new stratigraphic and tectonic data.

GRELL, K. G.

1956 – *Protozoologie.* Berlin: Verlag Springer, 284 pp., 300 text-figs.

A good summary of our present knowledge concerning the morphology, physiology, reproduction, genetics, and ecology of Recent Flagellata, Rhizopoda, Sporozoa, and Ciliata, with special attention to cytology.

1957 – *Untersuchungen über die Fortpflanzung und Sexualität der Foraminiferen; I – Rotaliella roscoffensis.* Archiv Protistenkunde, vol. 102, pp. 147–164, 2 text-figs., 11 pls.

Investigations into the cytology, ontogeny, alternation of generations, and culture of *Rotaliella roscoffensis.*

GROSPIETSCH, T.

*1957 – *Beitrag zur Rhizopodenfauna des Lago Maggiore.* Arch. Hydrobiol., vol. 53, pp. 323–331, 5 text-figs.

Eighteen rhizopods are named, and three species are described, from ten samples taken in the oligotrophic lake at depths of 30–300 meters.

GROSS, W.

*1957 – *Über die Basis der Conodonten.* Pal. Zeitschr., vol. 31, pp. 78–91, 3 pls., 4 text-figs.

Histological analysis of the growth of fillings in the bases of Silurian and Devonian conodonts.

HAGN, H.

1957 – *Das Profil des Beckens von Gosau (Österreichische Kalkalpen) in mikropaläontologischer Sicht.* Österr. Akad. Wiss., Anzeiger, no. 4, pp. 31–67.

Discussion of the micropaleontological horizons of the Gosau section; the Zwieselalm beds are thought to be Danian, and the Nierentaler beds Maestrichtian and upper Campanian.

HAGN, H., AND ZIEGLER, J.

*1957 – *Zur Entstehung "pseudolabyrinthischer" Strukturen bei sandschaligen Foraminiferen.* Pal. Zeitschr., vol. 31, pp. 66–77, 2 pls.

Sometimes the replacement of calcium carbonate by pyrite produces a false labyrinthic structure of the shell, which reduces the taxonomic value of labyrinthic structure in the foraminifera.

HALLIK, R.

1957 – *Eine Flüssigkeit zur Trennung von organischem Material und Sand für Pollenanalyse.* Neues Jahrb. Geol. Pal., Monatshefte, pt. B, pp. 188–189.

Application of K_2CdI_4, a non-poisonous substance with a specific gravity of 2.5.

HARTMANN, G.

*1957 – *Ostracoden aus dem Namaland und Transvaal.* Naturwiss. Ver. Osnabrück, Veröff., vol. 28, pp. 50–60, 21 text-figs.

Description of six Recent limnic species of ostracodes, including two new genera, *Chrissia* and *Gesa*, and three new species.

*1957 – *Neue Funde von Muschelkrebsen (Ostracoden) im Gebiet der Nordseeküste und der Kieler Bucht.* Naturwiss. Ver. Schleswig-Holstein, Schriften, vol. 28, pp. 103–112, 17 text-figs.

Twenty-one genera, with thirty-nine species, are named, with their localities; *Microcythere schüttei*, n. sp., from Sylt, and two new subspecies of *Leptocythere lacertosa*, from the Jade, are described.

*1957 – *Zur Kenntnis des Mangrove-Estero-Gebietes von El Salvador und seiner Ostracoden-Fauna; II.* Kieler Meeresforsch., vol. 13, pp. 134–159, 12 pls.

Twelve new species of the ostracode genera *Cyprideis*, *Ilyocythere*, *Elofsonella*, *Cytherura*, *Paracytheroma*, and the new genera *Thalassocypria* and *Pericythere*, living in the "Watt" and "Mangrove" biotopes, are described.

1957 – *Ostracoden aus den Mangroven Brasiliens.* Zool. Anzeiger, vol. 158, pp. 209–217, 25 text-figs.

Descriptions based on the extremities are given for three new species belonging to the genera *Ilyocythere*, *Pericythere* and *Cytherura.*

HASEMANN, W., AND HEINEMANN, W.

1957 – *Mittel- und Oberoligozän (Rupelien und Chattien) an der Ostseite des Kaiserstuhls.* Baden, Landesver. Naturk., Mitt., new ser., vol. 7, pp. 1–5.

New zoning on the basis of eleven Tertiary samples with sparse foraminiferal faunas.

1957 – *Unteroligozän (Sannoisien) an der Ostseite des Kaiserstuhls.* Naturf. Ges. Freiburg i. Br., Ber., vol. 47, pp. 55–69.

Zonation, with brief mention of charophytes, foraminifera and ostracodes.

HERMANN, H.

1957 – *Die Entstehungsgeschichte der postglazialen Kalktuffe der Umgebung von Weilheim (Oberbayern).* Neues Jahrb. Geol. Pal., Abh., vol. 105, pp. 11–46, 12 text-figs.

In addition to petrography and megafossils, the author also presents a pollen-diagram and an analysis of diatoms by H. J. Weinzierl.

HILTERMANN, H.

1956 – *Biostratigraphy der nordwestdeutschen Oberkreide mittels Foraminiferen.* Congr. Geol. Internat., XV (Mexico, 1956), Res. Trab. Pres., p. 332. (Abstract.)

Research on transcontinental stratigraphy, using small benthonic foraminifera.

1957 – *Rudolf Richter — 1881–1957.* Micropaleontology, vol. 3, no. 2, p. 192, 1 portr.

A brief review of the accomplishments of this great paleontologist, who died January 5, 1957.

1957 – *News report: Germany.* Micropaleontology, vol. 3, no. 3, p. 296.

Reports of various lectures, meetings, and excursions.

1957 – *Carl A. Wicher zum Gedenken — 11. V. 1901–3.IV. 1957.* Erdöl und Kohle, vol. 10, p. 328, 1 portr.

Obituary of the founder of Mesozoic microstratigraphy, including a bibliography with thirty-seven titles.

1957 – *Annotated bibliography of micropaleontology in Germany for 1956.* Micropaleontology, vol. 3, no. 4, pp. 399–406.

One hundred twelve papers on all fields of micropaleontology are listed and briefly reviewed.

HILTERMANN, H., AND KOCH, W.

*1957 – *Revision der Neoflabellinen (Foram.); Teil I – Neoflabellina rugosa (d'Orb.) und ihre Unterarten.* Geol. Jahrb., vol. 74, pp. 269–304, 8 pls., 5 text-figs., 1 table.

Revision of *Neoflabellina rugosa* and its subspecies *leptodisca*, *sphenoidalis*, and *caesata*, on the basis of more than 10,000 samples. The taxonomic value of various characters is discussed.

1957 – *Biostratigraphische Ergebnisse im Schacht Graf Bismarck 10 mittels Foraminiferen.* Geol. Jahrb., vol. 74, pp. 327–331, 1 text-fig.

A 240-meter section is subdivided into upper Turonian, Coniacian, lower Santonian, and middle Santonian; the vertical ranges of seven species of *Globotruncana*, three of *Neoflabellina*, and two of *Stensioina* are given.

HOEHNE, K.

1957 – *Fischschuppen im Vitrit unterrotliegender Steinkohlenflöze von Stockheim und Manebach in Thüringen.* Geologie, vol. 6, pp. 528–532, 8 pls.

Descriptions of thin sections of scales of *Acanthodes* found in allochthonous coal in the Rotliegend.

HOFKER, J.

*1957 – *Foraminiferen der Oberkreide von Nordwestdeutschland und Holland.* Geol. Jahrb., Beiheft no. 27, 464 pp., 495 text-figs.

Descriptions and illustrations of 228 foraminiferal species, among which twenty-three are new, belonging to forty-four genera. Taxonomic importance of internal characters, such as pores, toothplates, and shell structure. *Angulogavelinella* and *Valvoreussella* are new genera. Tables show the stratigraphic occurrence of the specimens studied. Discussion of variability in the foraminifera.

1957 – *Geologische Chronologie und Evolution von Foraminiferen-Arten.* Neues Jahrb. Geol. Pal., Monatshefte, pt. B, pp. 338–342.

Brief reference to biostratigraphic problems in the Upper Cretaceous.

HUSTEDT, F.

1956 – *Kieselalgen (Diatomeen).* Stuttgart: Kosmos Verlag, 70 pp., 35 text-figs., 4 pls.

Notes on the morphology and ecology and on the preparation of marine and limnic diatoms. Tables for the determination of families and genera.

*1957 – *Die Diatomeenflora des Flußsystems der Weser im Gebiet der Hansestadt Bremen.* Naturw. Ver. Bremen, Abh., vol. 34, pp. 181–440, 1 pl., 102 text-figs.

Diatoms from 200 samples are classified under sixty-four genera, with 482 species, among which nineteen are new, and 133 vareties. A detailed ecological evaluation is concerned especially with the halophytes and saprophytes.

JUX, U., AND PFLUG, D.

1957 – *Zur Geologie und Technologie der Braunkohle in der niederrheinischen Bucht.* Braunkohle, Wärme und Energie, vol. 9, pp. 257–266, 8 text-figs.

The importance of palynology in the geology and technology of brown coal.

KLEMENT, K. W.

*1957 – *Revision der Gattungszugehörigkeit einiger in die Gattung Gymnodinium eingestufter jurassischer Dinoflagellaten.* Neues Jahrb. Geol. Pal., Monatshefte, pt. B, pp. 408–410, 1 text-fig.

Discovery of the interior capsule, an important character; description of *Seriniodinium*, n. gen.

KÖLBEL, H., AND KRUTZSCH, W.

1957 – *Stratigraphie, Erdölgeologie und Paläontologie auf der 20. Tagung dès Internationalen Geologenkongresses in Mexiko 1956.* Angewandte Geologie, vol. 3, pp. 160–172, 8 text-figs., 1 table.

Report of lectures and excursions in Mexico; micropaleontology is treated as a separate section.

KÖWING, K.

1957 – *Zur Gliederung des nordwestdeutschen Miozäns.* Neues Jahrb. Geol. Pal., Monatshefte, pt. B, pp. 83–91.

Proposal to subdivide the Miocene in northwestern Germany on the basis of its deep-water marine sections only.

1957 – *Die Miozängeschiebe.* Naturh. Ges. Hannover, Ber., vol. 103, pp. 71–75.

Brief reference to *Nonion* and *Ceratobulimina* in Miocene boulders in Pleistocene deposits.

KRÄUSEL, W.

*1957 – *Loculipora Hall aus dem Mitteldevon des Rheinischen Schiefergebirges und des Harzes.* Senckenbergiana Lethaea, vol. 38, pp. 335–344, 1 text-fig., 1 pl.

Revision and illustration of *Loculipora alvearis*, and description of *Loculipora* cf. *alvearis*.

KRUTZSCH, W.

1957 – *Resumee über die hauptsächlichen gegenwärtigen mikropaläontologischen Arbeiten in der Deutschen Demokratischen Republik.* Congr. Geol. Internat., XX (Mexico, 1956), Res. Trab. Pres., p. 177.

Brief note on work being carried on in East Germany.

1957 – *Sporen- und Pollengruppen aus der Oberkreide und dem Tertiär Mitteleuropas und ihre stratigraphische Verteilung.* Angewandte Geologie, vol. 3, pp. 509–548, 16 pls., 1 text-fig., 2 tables.

Thirty associations ("Bilder"), with 800 photomicrographs of spores and pollen, based on 10,000 slides ranging in age from Cenomanian to Pliocene, used in stratigraphic determination by means of pollen.

1957 – *Sporenpaläontologische Untersuchungen in der sächsisch-böhmischen Kreide und die Gliederung der Oberkreide auf mikrobotanischer Grundlage.* Geol. Ges. D.D.R., Ber., vol. 2, pp. 126–131, 1 table.

Illustrations and vertical ranges of thirty-five sporomorphs from the Upper Cretaceous.

KRUTZSCH, W., AND LOTSCH, D.

1957 – *Zur stratigraphischen Stellung der Latdorfstufe im Paläogen.* Geologie, vol. 6, pp. 476–501, 4 tables.

Stratigraphy, together with palynologic data and sections, especially of new borings in southern Brandenburg. Petrographic tables for comparison. The Latdorf beds (formerly "Lattorf") prove to be a littoral facies of the Upper Eocene. Table showing the vertical ranges of seventy-five sporomorphs.

MALZ, H.

*1957 – *Macrodentina maculata n. sp., ein stratigraphisch wichtiger Ostracod im Oberen Malm.* Senckenbergiana Lethaea, vol. 38, p. 250.

Description of a new species from the Aldorfer otolith deposits (Münder Mergel).

MALZAHN, E.

1957 – *Neue Fossilfunde und vertikale Verbreitung der niederrheinischen Zechsteinfauna in den Bohrungen Kamp 4 und Friedrich Heinrich 57 bei Kamp Lintfort.* Geol. Jahrb., vol. 73, pp. 91–126, 4 pls., 1 text-fig., 1 table.

Megafossils and forty-one foraminifera (identified by H. Hiltermann), some ostracodes, conodonts, and other microfossils, and their vertical ranges.

MARTIN, G. P. R.

1957 – *A new method of recovering remains of the chitinous integument of fossil Ostracoda.* Micropaleontology, vol. 3, no. 3, pp. 291–292.

Brief account of the work of Gocht and Goerlich on the recovery of the chitinous remains of fossil ostracodes.

MARTIN, G. P. R., AND WEILER, W.

*1957 – *Das Aldorfer Otolithen-"Pflaster" und seine Fauna (Mittlerer Münder Mergel, Malm).* Senckenbergiana Lethaea, vol. 38, pp. 211–249, 3 pls., 2 text-figs., 1 table.

Descriptions and illustrations of three new index ostracodes and nineteen otoliths, including one new species, from the upper Malm 4a, a characteristic horizon in well sections.

MATTHES, H. W.

1957 – *Der gegenwärtige Stand der mikropaläontologischen Forschung.* Forschung und Fortschritte, vol. 31, pp. 33–39, 32 text-figs.

It is emphazised that all groups of microfossils should be investigated.

MAYR, M.
1957 – *Geologische Untersuchungen in der ungefalteten Molasse im Bereich des unteren Inn.* Geol. Jahrb., Beiheft, no. 26, pp. 323–324.

A note on the classification of the Helvetian by means of ostracodes.

MOOS, B.
*1957 – *Die Ostracoden-Gattung Triginglymus D. B. Blake 1950 als Synonym von der Gattung Leguminocythereis H. V. Howe 1936.* Geol. Jahrb., vol. 72, pp. 501–502.

Material from Astrup and the Paris Basin shows that the "anti-slip tooth" used in distinguishing the genus represents the attachment of a muscle.

MÜLLER, A. H.
1957 – *Lehrbuch der Paläozoologie; Bd. I — Allgemeine Grundlagen.* 322 pp., 177 text-figs.

In addition to general remarks on the ontogeny of the fusulinids and nummulites, there is a short appendix on micropaleontological preparation techniques.

PFLUG, H. D.
*1956 – *Sporen und Pollen vom Tröllatunga (Island) und ihre Stellung zu den pollenstratigraphischen Bildern Mitteleuropas.* Neues Jahrb. Geol. Pal., Abh., vol. 102, pp. 409–430, 3 pls.

New discoveries of probably Eocene clays at a locality heretofore believed to be Miocene. Twenty-six index spores are listed by name and figured, and are compared with similar forms from Spitzbergen.

1957 – *Zur Altersfolge und Faziesgliederung mitteleuropäischer (insbesondere hessischer) Braunkohlen.* Hessen, Landesamt Bodenf., Notizbl., vol. 85, pp. 152–178, 5 text-figs., 9 tables, 3 pls.

Descriptions of two sections comprising 8 meters of Eocene and Miocene brown coal near Kassel; vertical ranges, diagrams, and fifty photomicrographs of microspores.

PIERART, P.
*1957 – *Note préliminaire sur les mégaspores du Westphalian C supérieur en Campine belge.* Pal. Zeitschr., vol. 31, pp. 46–52.

The importance of mega- and miospores in the recognition and subdivision of the Westphalian C"; descriptions of three megaspores.

REMY, W., AND REMY, R.
*1957 – *Durch Mazeration fertiler Farne des Paläozoikums gewonnene Sporen.* Pal. Zeitschr., vol. 31, pp. 55–65, 3 pls.

Descriptions and photographs of seventeen spores (twelve genera) recovered from fructifications.

RUTTE, E.
1956 – *Die Geologie des Schienerberges (Bodensee) und der Öhninger Fundstätten.* Neues Jahrb. Geol. Pal., Abh., vol. 102, pp. 143–182, 10 pls., 24 text-figs., 1 table.

Reference to gastropods and ostracodes from the "upper fresh-water Molasse" of the Upper Miocene.

SCHAD, A.
1957 – *Einige Ergebnisse des Erdölaufschlusses bei Landau, Rheinpfalz.* Geol. Jahrb., vol. 74, pp. 243–268, 1 pl., 8 text-figs.

Microfossils important in the stratigraphy of the Oligocene, the "Lymnaenmergel," and the Aquitanian are mentioned.

SCHALK, K.
1957 – *Geologische Untersuchungen im Ries: Das Gebiet des Blattes Bissingen.* Geologica Bavarica, vol. 31, 107 pp., 80 text-figs., 3 pls., 1 map.

Brief reference to foraminifera in the upper marine Molasse (identified by Hagn). Descriptions and stratigraphic significance of remains of very small vertebrates.

SCHENK, E.
1957 – *Corbiculaschichten und Cyrenenmergel im Horloffgraben (Wetterau).* Hessen, Landesamt Bodenf., Notizbl., vol. 85, pp. 224–254, 3 text-figs.

Petrography and correlation of eight well sections in the Oligocene, with the aid of microfossils (foraminifera and ostracodes, the latter identified by Triebel).

SCHERF, H.
1957 – *Der Goldköcherwurm Pectinaria koreni.* Natur und Volk, vol. 87, pp. 108–111, 3 text-figs.

Description of the tube which the worm constructs by cementing sand.

SCHNEIDER, H. E.
*1957 – *Ein Megasporenfund aus dem Oberen Stefan des Saarkarbons.* Univ. Saraviensis, Ann., Naturw. Sci., vol. 5, no. 4, pp. 284–287, 2 pls.

Description and synonymy of *Laevigatisporites primus.*

SIEVERTS-DORECK, H.
1957 – *Bemerkungen über altpaläozoische Crinoiden aus Argentinien.* Neues Jahrb. Geol. Pal., pp. 151–156, 4 text-figs.

Discussion of five species from Salagasta (Mendoza), believed to be Ordovician.

SIMONSEN, R.

1957 – *Spätglaziale Diatomeen aus Holstein.* Archiv Hydrobiol., vol. 53, pp. 337–349, 1 insert, 1 table.

The diatoms of a 2.3-meter section of the latest glacial stage; the boreo-alpine diatoms of "Alleröd" indicate the climate. List of twenty-four species and varieties.

STACH, E.

*1957 – *Die Anschliff-Sporendiagnose des Ruhrkohlenflözes Baldur.* Palaeontographica, vol. 102, pt. B, pp. 71–95, 4 tables.

New method of classification of spores in polished sections of coal, based only on the thickness and sculpture of the exine; descriptions of new form-genera and twenty-nine new species.

STACH, E., AND PICKHARDT, W.

*1957 – *Pilzreste (Sklerotinit) in paläozoischen Steinkohlen.* Pal. Zeitschr., vol. 31, pp. 139–162, 4 tables.

Descriptions and figures of thirty-seven remains of sclerotic fungi in Paleozoic coals. Thin sections and polished sections of nineteen new species and nine new genera.

TEICHMÜLLER, R., AND ZIEGLER, W.

1957 – *Devonkalk-Gerölle im Zechsteinkonglomerat von Rossenray (SW Rheinberg).* Neues Jahrb. Geol. Pal., Monatshefte, pp. 267–274, 2 text-figs.

Paleogeographic conclusions drawn from pebbles classified by means of conodonts; list of twenty-nine species identified by W. Ziegler.

THEWS, J. D.

1957 – *Die Oppenheimer Fazies und ihre Lebewelt an der Wende vom Alt- zum Jungtertiär.* Hessen, Landesamt Bodenf., Notizbl., vol. 85, pp. 179–205, 7 text-figs., 1 table, 2 pls.

Micropaleontological data concerning the bionomy of the "Cerithienschichten" and the "Landschnecken-Kalke." Short list of foraminifera, and three ostracodes (the latter identified by Goerlich).

THIERGART, F.

1957 – *Pollenfloren einiger Bodenproben aus dem Gebiet des Rio Morahu in Brasilien.* In: DIETZ, C.: *Der Marahunit, seine Verbreitung und stratigraphische Stellung im Tertiär usw.* Geol. Jahrb., Beiheft, no. 25, pp. 124–129, 2 pls., 1 table.

Frequencies of pollen and spores found in six samples; microphotographs.

TRIEBEL, E.

*1957 – *Neue Ostracoden aus dem Pleistozän von Kalifornien.* Senckenbergiana Lethaea, vol. 38, pp. 291–309, 5 pls.

Descriptions and detailed illustrations of *Palmenella californica*, n. sp., and of four new species of *Munseyella.*

VANGEROW, E. F.

*1957 – *Mikropaläontologische Untersuchungen in den Kohlscheider Schichten im Wurmrevier bei Aachen.* Geol. Jahrb., vol. 73, pp. 457–506, 5 pls., 15 text-figs., 3 tables.

Descriptions of fourteen rare ostracodes, preserved only as internal molds, belonging to four genera, among them *Jonesina symmetrica*, n. sp.; also megaspores, one *Spirorbis*, and few foraminifera; all from the upper Westphalian A.

VOIGT, E.

*1957 – *Harmeriella? cretacea n. sp., ein fragliches parasitisches Bryozoon aus der Schreibkreide von Rügen.* Senckenbergiana Lethaea, vol. 38, pp. 345-357, 6 text-figs., 1 pl.

Description of minute comma-shaped depressions on colonies of an encrusting form of *Stichomicropora;* classified as related to the Recent genus *Harmeriella.*

WALLISER, O. H.

*1957 – *Conodonten aus dem oberen Gotlandium Deutschlands und der Karnischen Alpen.* Hessen, Landesamt Bodenf., Notizbl., vol. 85, pp. 28–52, 3 text-figs., 1 table, 3 pls.

Descriptions and illustrations of twenty-eight conodonts (eight new species) belonging to twelve genera (including *Kockelella*, n. gen.); the material comes from definitely dated Upper Gotlandian localities in the "Rheinische Schiefergebirge," the Frankenwald, and the Carnic Alps.

WASBUZKY, I.

1957 – *Die geologischen Verhältnisse der Ziegeleigruben am Bahnhof Westend-Blankenburg unter besonderer Berücksichtigung der Makro- und Mikrofauna.* Geologie, vol. 6, p. 329. (Abstract.)

Scarce microfaunas of long-ranging benthonic foraminifera were found only in thirty of the more clayey samples of the "Blankenburg Schichten" (lower Campanian).

WEILER, W.

1957 – *Fischreste aus dem Tertiär von Epterode südlich von Großalmerode.* Hessen, Landesamt Bodenf., Notizbl., vol. 85, pp. 24–27, 10 text-figs.

The author classifies a marl bed intercalated in marine clays as Middle Oligocene on the basis of fish remains, especially scales.

1957 – *Zur Fischfauna des Doberges bei Bünde in Westfalen.* Pal. Zeitschr., vol. 31, pp. 135–138.

Identification of remains, especially otoliths, of fourteen selachians and fourteen teleostomes.

WETZEL, O.
1957 – *Fossil "microforaminifera" in various sediments and their reaction to acid treatment.* Micropaleontology, vol. 3, no. 1, pp. 61–64, 1 pl.

Brief discussion, with twenty-eight figures showing the chitinous remains of various microfossils.

WETZEL, W.
1957 – *Selektive Verkieselung.* Neues Jahrb. Geol. Pal., Abh., vol. 105, pp. 1–10, 3 pls.

Short note on secondary silicification of foraminifera.

*1957 – *Die Foraminiferengattung Ramulina im Eozän Europas.* Neues Jahrb. Geol. Pal., Monatshefte, pp. 53–58, 4 text-figs.

Description of a new subspecies of *Ramulina kittli* from the Bartonian near Kiel.

WEYLAND, H., AND PFLUG, H. D.
*1957 – *Die Pflanzenreste der pliozänen Braunkohle von Ptolemais in N-Griechenland.* Palaeontographica, vol. 102, pt. B, pp. 96–109, 2 pls., 1 text-fig.

Climatic significance of pollen and spores contained in two samples of brown coal, and descriptions of eight new species of pollen.

WICHER, C. A.
1957 – *Die mikropaläontologische Gliederung des nichtmarinen Keuper.* Erdöl und Kohle, vol. 10, pp. 3–7, 2 text-figs., 1 pl.

Descriptions of twelve bionomic horizons on the basis of twenty-one ostracodes, nine megaspores, two foraminifera, and *Chara* oogonia, and their vertical ranges.

*1957 – *Die Gattung Gomphocythere in NW-Deutschland und das Problem der brackischen Ostracoden.* Micropaleontology, vol. 3, pp. 269–275, 2 pls.

Six species of *Gomphocythere* are known from the Jurassic-Cretaceous transition beds. They are reduced to two species, with six subspecies. Discussion of problems concerning the morphology and taxonomy of brackish-water Ostracoda.

WICHER, C. A., AND BETTENSTAEDT, F.
1957 – *Zur Oberkreide-Gliederung der bayerischen Innviertel-Bohrungen.* Geologica Bavarica, vol. 30, pp. 3–54, 3 text-figs., 1 table.

Supplementation of the former subdivision of three borings penetrating the upper Campanian to Turonian by means of twenty index foraminifera, including *Ventilabrella deflaensis.*

ZIEGLER, J. H.
1957 – *Beitrag zur Kenntnis des Oberen Cenoman in der Oberpfalz.* Neues Jahrb. Geol. Pal., pp. 195–206.

List of the foraminifera of the marl beds. The "Sulzbacher Kalk" is believed to be upper Cenomanian on the basis of three species of *Globotruncana,* which are described.

ZIEGLER, J. J.
1957 – *Die Fauna des Cardientones der Oberpfalz und die Bedeutung der Foraminiferen für seine Altersbestimmung (Coniac).* Geologica Bavarica, vol. 30, pp. 55–86, 3 tables, 1 pl.

List of the fauna obtained from seven borings penetrating the Cardium clay, now assigned to the Coniacian. Descriptions of the foraminifera (two new species), twelve of which are figured.

ZIEGLER, W.
1957 – *Das Marburger Gotlandium.* Hessen, Landesamt Bodenf., vol. 85, pp. 67–74, 4 text-figs.

Significant Silurian graptolites have been found in tectonic inliers in the Upper Devonian; a list of Upper Devonian conodonts is appended.

ZÖBELEIN, H. K.
1957 – *Kritische Bemerkungen zur Stratigraphie der Subalpinen Molasse Oberbayerns.* Hessen, Landesamt Bodenf., Abh., vol. 23, 91 pp., 2 text-figs.

The boundary between the Chattian and Aquitanian is established on the basis of limnic gastropods found between the Cyrenen and Promberger beds; ostracodes are also identified by Goerlich, and foraminifera by Knipscheer.

Directory of North American palynologists

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In view of the increasing interest in palynological work, I feel that a directory of North American palynologists is desirable. To my knowledge, the last attempt to list palynologists was in 1954 (The Micropaleontologist, vol. 8, no. 3). Since then, many changes have occurred. Below is a listing of persons in the United States and Canada who are engaged in palynological research and/or the application of polospores to scientific problems. I would appreciate it if omissions and corrections were brought to my attention.

ALPHABETICAL LISTING

AMES, H. TATE, Department of Geology, Pennsylvania State University, University Park, Pennsylvania.

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news reports

FRANCE

JEAN CUVILLIER

Institut Français du Pétrole
Département de Géologie Sédimentaire

During the past year a great deal of routine service work was done by the "Bureau d'Études Stratigraphiques," under the supervision of J. Sigal. Important stratigraphic work for various companies in Madagascar, New Caledonia, and the Paris Basin was carried on. Research activities concerned conodonts, ostracodes, Chitinozoa, foraminifera, spores and pollen, and other microfossils.

M. Lys and Mrs. B. Serre published the results of their work on conodonts and their distribution in the Paleozoic of Austria, Spain, Montagne Noire, France, and the Sahara (C. R. Acad. Sci., vol. 244, 1957; Revue Inst. Franç. Pétr., vol. 12, nos. 7, 8, and 10, 1957).

The Ostracoda and their distribution in the Upper Jurassic and Lower Cretaceous of the Belgian Congo were studied by N. Grékoff (Ann. Mus. Roy. Congo Belge, ser. 8, vol. 10). Those of the Tertiary were published in vol. 11 (1957). The application of ostracodes in the chronostratigraphy of the Maestrichtian at the type locality was established by G. Deroo. V. Apostolescu is continuing his research on Tertiary Ostracoda.

The laboratory of palynology and Chitinozoa is now fully established. A large collection of Paleozoic material from the Sahara has already been collected and studied under the supervision of J. B. de Jekhowsky. P. Taugourdeau is especially interested in Chitinozoa and Hystrichosphaera. Miss J. Lantz is still working on Cenozoic spores.

Some publications dealing with foraminifera have been presented by J. Sigal and C. Perrot (C. R. Somm. Soc. Géol. France, no. 10, 1957), and by J. Sigal, R. Busnardo, M. Durand-Delga, and P. Fallot (C. R. Acad. Sci., vol. 245, no. 5, 1957). New data on the morphology and stratigraphic distribution of *Microcodium* were obtained by J. Sigal and S. François (C. R. Somm. Soc. Géol. France, no. 10, 1957). M. Bourdon has described a method of utilizing acetic acid in the disaggregation of hard rocks (Revue Inst. Franç. Pétr., vol. 12, 1957).

University of Paris
Laboratoire de Micropaléontologie

There are now forty students in the Laboratory of Micropaleontology; about twelve "diplômes d'études supérieures" and several theses are being prepared. Teaching is under the direction of Professor J. Cuvillier, with the collaboration of Mrs. M. Neumann and D. Boulanger. Special courses are given, in addition, by N. Grékoff (Ostracoda), B. Alpern (palynology), and M. Lezaud. Samples have been received mainly from North Africa and from Aquitaine and other parts of France.

Two theses for the D.Sc. were presented during the past year. Mrs. Neumann, in her thesis entitled "Revision des orbitoididés du Crétacé et de l'Éocène en Aquitaine occidentale," presented the results of five years of detailed research. Two new species were described, *Asterodiscus cuvillieri* and *Discocyclina daguini*. Mrs. Neumann demonstrated that it is possible to make identifications with numerous thin sections of rocks. Her paper is to be published, with numerous plates, in the "Mémoires de la Société Géologique de France."

B. Alpern presented a thesis entitled "Contribution aux méthodes et à la systématique palynologique et pétrographique des charbons," which included a section on "Application au problème de la corrélation des couches." This important work, which is amply illustrated, is to be published at a later date. C. W. Wagner has published a detailed study, "Ostracodes du Quaternaire récent des Pays-Bas," including their application in the geologic study of Holocene deposits (thèse d'Université, 158 pp., 50 pls., Mouton & Co., The Hague, 1957). Miss Rouvillois is nearing the conclusion of her thesis, dealing with "Hydrogéologie et micropaléontologie du Thanétien du Bassin de Paris."

Among the "diplômes d'études" we may mention "Études stratigraphiques et micropaléontologiques dans les sondages de l'anticlinal de Beynes (Seine)," presented by Mr. Bellon, and "Étude géologique de la Côte Basque," by Mr. Delmas, in which new findings based mainly on detailed micropaleontological study have been obtained.

D. Boulanger is progressing in his "Revision du Nummulitique des Landes." In connection with this work, he has reported the presence of *Nummulites striatus* in Chalosse (C. R. Somm. Soc. Géol. France, no. 1, pp. 24–25). In collaboration with P. Cros, he has also published a good

description of *Microcodium* from the Montian of Aude (Bull. Soc. Géol. France, ser. 6, vol. 7, pp. 353–354).

A. Poignant has begun a revision of the Lower Cretaceous of Aquitaine, and Mrs. Poignant has started a detailed micropaleontological study of the Oligocene and Miocene of the same region. G. Aurouze, who has replaced L. Biot in the specialized study of the Jurassic foraminifera, has presented a complete revision of the genus *Kilianina* (C. R. Somm. Soc. Géol. France, no. 14, 1957). Mrs. Le Blanc, in charge of the library of the laboratory, has completed her studies on foraminifera from west-central Africa. Many micropaleontologists, both French and foreign, have utilized the library and collections of the laboratory.

Bureau de Recherches Géologiques, Géophysiques et Minières
Paris

During 1957, the micropaleontological activities of the B.R.G.G.M. were concerned with both fossil and Recent foraminifera. P. Marie presented a paper on some French deposits with *Microcodium* (C. R. Somm. Soc. Géol. France, no. 10, 1957). M. Clin and P. Marie reported the presence of a subsidence deep in the Argonne extension of the Marne double fault (Bull. Soc. Géol. France, ser. 6, vol. 8, 1957).

The Valanginien of Mont Rose, in the Madrague (Massif de Marseilleveyre, Bôuches-du-Rhône) has been revised by P. Marie and D. Mongin (Bull. Soc. Géol. France, ser. 6, vol. 8, 1957). In this paper, Marie reports the distribution of the Valanginian foraminifera of Mont Rose, particularly *Pfenderina neocomiensis*, *Pseudocyclammina lituus*, *Trocholina alpina*, *Nautiloculina oolithica*, and *Spirocyclina choffati*. A paper concerning the new genus *Goupillaudina* and its species is also being prepared by Marie.

Mrs. Le Calvez has two papers in press on Recent foraminifera (systematic and ecologic studies). One is on the distribution of foraminifera in the Baie de Villefranche-sur-Mer (Miliolidae), and the other is a study of the Celtic Sea foraminifera.

École Pratique des Hautes Études, Paris
Laboratory of Micropaleontology

Studies on Carboniferous Radiolaria (Visean of Montagne Noire, southern France) have been carried on actively by Professor G. Deflandre, especially during the summer, at Forcalquier. The microfauna of the phosphorites seems to be much richer than was previously recognized, and publication of a detailed memoir presenting the complete results will be delayed. Preliminary notes (C. R. Acad. Sci., vol. 246, pp. 968 and 2278) contain data concerning the ontogeny of the shell of *Sphaerellaria*, with remarks on the systematics of a new species of *Cubosphaera*, which is classifiable in five of Haeckel's genera (this note was published in collaboration with Mme. Deflandre), and the description of a new genus, *Lapidopiscum*, the type of a new family belonging to the order Albaillellidea Deflandre, 1953.

Oligocene continental clays from Forcalquier contain reworked Eocene forms of coccoliths. A new type, *Goniolithus*, with pentagonal coccoliths, was described by G. Deflandre (C. R. Acad. Sci., vol. 244, p. 2539, 1957) and has been found again by Mme. Deflandre in the Eocene of northern Germany, in a boring at Wöhrden. Continuing the study of the detailed morphology of the coccoliths, G. Deflandre, together with L. Durrieu (Laboratory of Electronic Optics of the C.N.R.S., Toulouse), has made a contribution to the knowledge of two species of *Discolithus*, which are now classified as *Cribrosphaerella* (C. R. Acad. Sci., vol. 244, p. 2948, 1957).

It is well known that tintinnids (*Calpionella*, etc.) are the only fossil ciliates recognized to date. G. Deflandre and J. Deunff have published a preliminary note (C. R. Acad. Sci., vol. 244, p. 3090, 1957) on the first representatives of the living marine family Folliculinidae. The thecae of *Priscofolliculina*, nov. gen., are abundant and beautifully preserved in a flint from the Gabon (age uncertain).

A short but important paper on pre-Cambrian microfossils by G. Deflandre (C. R. Acad. Sci., vol. 244, p. 2640, 1957) presents the author's opinions concerning the genus *Arnoldiana* Hovasse, 1956, which is not a foraminifer, and the genus *Cayeuxipora* Graindor, 1957, the siliceous composition of which is by no means proven.

Continuing her work on holothurian sclerites, Mme. M. Deflandre-Rigaud has been working on Oligocene samples from Germany. She has published a short English translation of her memoir on the alcyonarian sclerites (Micropaleontology, vol. 3, p. 357, 1957). In another paper (Paris, Mus. National Hist. Nat., Bull., vol. 29, p. 353, 1957), the invalidity of the name *Theelia* Schlumberger, 1890 (non Ludwig, 1889) was clearly demonstrated. She has also discovered the oldest known *Micrascidites* (ascidian sclerites) in a Danian flint from Denmark.

Jean Deunff, working on Paleozoic microfossils at the University of Rennes, has described a very peculiar new type (incertae sedis) from the Silurian of Brittany (*Ampelitocystis*), as well as a number of new species of hystrichospherids from the Devonian of Canada (Soc. Géol. Min. Bretagne, Bull., new ser., vol. 2, p. 1, 1957).

L. Decloître's studies on Recent thecamoebians were published in the Bulletin de l'Institut Français d'Afrique Noire (Rhizopod fauna A.O.F., 1956, p. 377, and 1957, p. 367), and in the Mémoires de l'Institut Scientifique de Madagascar (Thecamoebian fauna of Madagascar, no. 11A, p. 1, 1956).

Many French workers have completed investigations in various fields at the laboratory. Mlle. S. Durand, of the University of Rennes, is writing a second paper on the Tertiary hystrichospherids of Brittany. She has found interesting forms which will apparently make possible stratigraphic correlation with other areas.

Foreign research workers have also visited the laboratory. Among them were Professor Barghoorn, of Harvard University (pre-Cambrian mi-

crofossils); Professor M. N. Bramlette, of La Jolla, California, who visited the laboratories in Paris and later came to Forcalquier with his wife and daughter (a paper in collaboration with G. Deflandre on the stratigraphy of coccoliths is in preparation); Dr. P. E. Cloud, of the U. S. Geological Survey, Washington; Dr. Otto Wetzel, of Eutin, Germany, who stayed two weeks at Forcalquier, discussing various microfossils, especially those recovered from flints (Dr. Wetzel now agrees with G. Deflandre that the peculiar form *Triblastula* O. Wetzel is a dinoflagellate). The laboratory has been consulted frequently with regard to numerous questions dealing with various kinds of microfossils.

Professor G. Deflandre was elected a Corresponding Member of the Austrian Academy of Sciences at Vienna in May, 1957. He was also elected a Foreign Member of the Royal Flemish Academy at Brussels, Class of Sciences, in October, 1957.

Compagnie Française des Pétroles, Paris
Laboratoire de Sédimentologie

The staff of this laboratory consists of four geologists: G. Nouet, as head; R. Lacassagne, his assistant, who specializes in problems concerning microfacies and in the general direction of operations and methods; and Miss G. Nabos and Miss H. Garrot, who study free foraminifera and Ostracoda. During the year 1957, the activities of the laboratory were confined to the following studies, which are not yet complete:

Jurassic of the Paris basin: The correlation of the Dogger between the western and eastern parts of the basin, especially by means of microfacies, and linking these areas with Alsace.

Triassic-Jurassic-Cretaceous of the Rhône basin: Good horizons that provide possibilities for correlation in future drilling have been found only in the Jurassic and Cretaceous. These include a horizon with *Favreina* in the Hettangian; another with *Saccoma*, *Globochaete*, and *Calpionella* in the Kimeridgian–Portlandian; numerous microfaunas of foraminifera and Ostracoda that are characteristic of the Valanginian-Hauterivian; and *Protocythere triplicata*, *Protocythere hechti*, and *Cythereis senckenbergi*, characteristic of the Hauterivian.

Triassic-Jurassic-Cretaceous-Tertiary of the Ebro Basin (Spain): Microfacies and horizons with free microfauna have been found in the Cretaceous and Tertiary. The following horizons permit good correlation: The Aptian with *Orbitolina;* the Cenomanian with *Prealveolina;* the Senonian with *Lacazina* and *Monolepidorbis;* the Maestrichtian with *Lepidorbitoides socialis* and *Siderolites;* and the Lutetian with *Nummulites*, *Orbitolites complanatus*, *Alveolina elongata*, and *Flosculina*. The Upper Eocene with "*Orthophragmina*" is also very rich in various organisms.

Jurassic of the C.F.P. (Normandie): Detailed correlations have been established in the Bathonian and Bajocian between borings, on the one hand, and outcrops in Normandy, the Boulogne area, and the Ardennes, on the other hand. In connection with studies in sedimentology, some work on quantitative measurements of dolomite, concerning porosity, permeability, and solubility, has been carried on.

During the past year, there were four publications by members of the laboratory staff: G. Nouet (C. R. Somm. Soc. Géol. France, nos. 11, 12, 13), and G. Nouet and G. Nabos (C. R. Somm. Soc. Géol. France, nos. 11–12). Nouet spent two months in the United States studying the methods of work and research techniques used in various oil laboratories.

Université de Dijon
Laboratoire de Géologie

At Dijon, the outstanding event was the opening of the modern Faculté des Sciences, which was inaugurated on October 12, 1957. This should permit the laboratory, headed Professor R. Ciry, to be reorganized and enlarged in the near future.

P. Rat presented his thesis, entitled "Les pays crétacés basco-cantabriques (Espagne)," in May, 1957. This work is mainly concerned with the stratigraphy and sedimentology of the Urgonian formations. The analysis of the micropaleontological data bearing on such problems as the Jurassic-Cretaceous boundary, the Lower Cretaceous Orbitolinidae, and the Upper Cretaceous–Eocene transition had to be partially condensed for reasons of space.

H. Tintant is continuing to write his memoir on the Middle and Upper Jurassic foraminifera of Burgundy. J. P. Mangin is progressing in his study of Nummulitic foraminifera. He has published two notes: "La limite Cretacé–Tertiaire sur le versant Sud des Pyrénées occidentales" (C. R. Acad. Sci., vol. 244, pp. 1227–1229), and "Remarques sur le terme Paléocène et sur la limite Crétacé–Tertiaire" (C. R. Somm. Soc. Géol. France, 1957, pp. 315–317).

Mrs. M. Mangin has been devoting her attention to the Miliolidae, especially *Adelosina*. She has published a paper entitled "Contribution à l'étude du genre '*Adelosina*'" (Bull. Sci. Bourgogne, vol. 17, pp. 89–95). She has also studied a foraminiferal fauna collected during the Guinea expedition of the "Calypso" in 1956.

C.E.P. (Compagnie d'Exploration Pétrolière)
Chambourcy

Miss Aurouze and Mr. Bizon have left the staff of the Central Laboratory at Chambourcy. Miss Delisle, who now heads the foraminiferal section, has resumed her studies of the Lower Jurassic formations of the Paris Basin and of the Lower Cretaceous of the Aquitaine and Provence Basins. Mrs. Guichard has begun the identification of foraminifera from the Paleozoic of the Sahara. The biostratigraphic studies carried out by the Central Laboratory have led to a zonation of the Visean and Namurian (Mississippian) sections in the basin of Reggane on the basis of endothyrid and lituolid foraminifera. Routine work on well samples is carried on by the laboratory at St.-Germain-en-Laye by Mr. Durand, and at Bordeaux by Mr. Bellon. In partial fulfilment of the requirement for his "diplôme d'études supérieures" (1957) at the University of Paris, Mr. Bellon submitted a

stratigraphic and micropaleontological study of the Cretaceous formations penetrated by drilling in the structure at Beynes, west of Paris.

Dr. Oertli, the Company's specialist on ostracode faunas, is studying all the incoming Mesozoic material from wells and outcrop sections. A special study of the Ostracoda from the Aptian of the type locality, at Apt, in southern France, is ready for publication. At present he and his assistant, Mr. Grosdidier, are studying Liassic ostracode associations containing more than 100 species, which will form the basis of detailed stratigraphic subdivision. Dr. Oertli's thesis, "Ostrakoden aus der oligozänen und miozänen Molasse der Schweiz," has now been published (Schweiz. Pal. Abh., vol. 74), as well as his monograph on "Ostracodes du Jurassique supérieur du Bassin de Paris (sondage Vernon 1)" (Revue Inst. Franç. Pétrole, 1957, vol. 12, no. 6). Other publications deal with the relationships between some Bathonian ostracode associations and salinity in the Boulogne area (Eclogae Geol. Helv., vol. 50, no. 2, 1958), and with ostracodes from the Bernese Molasse (Rutsch, Drooger and Oertli, Naturf. Ges. Bern, Mitt., vol. 16, 1958). In addition, Dr. Oertli has just completed a monograph on the ostracodes of the Upper Jurassic of the Swiss Jura Mountains, which he compares with those of the Paris Basin and of northern Germany.

With regard to the concession areas held by the Company in the Sahara, good zonation of the Lower Carboniferous of the Reggane basin, based on more than 150 species of ostracodes, has been established since 1956. The study of the ostracode faunas of the Saharan Paleozoic is now largely undertaken by Mr. Rast, at Chambourcy.

Since January, 1957, Dr. Oertli has included the conodonts in his microfaunal investigations; about 140 species can now be used for purposes of correlation in the Devonian and Carboniferous of southern France, northern Spain, and the Sahara concessions. In order to relieve Dr. Oertli, Miss Petitot has recently been assigned to the study of the conodonts.

Wolf Maync, scientific consultant on micropaleontology and stratigraphy, has been able to continue his research on the lituolid foraminifera. Following a biometric and statistical study of the known species of *Pseudocyclammina*, he undertook a detailed investigation of the controversial genus *Spirocyclina*. He finds that all forms of "*Spirocyclina*" recorded from the Upper Jurassic and Lower Cretaceous of Portugal and the Tethys area differ from the as yet unfigured Senonian genotype of *Spirocyclina*, and should therefore be assigned to another genus. Dr. Maync's paper on this group, based on material from every locality in the world from which "*Spirocyclina*" has ever been recorded, has been submitted for publication. Some preliminary results of his study of *Spirocyclina* were already covered in one of the four papers presented by Dr. Maync at the Twentieth International Geological Congress in Mexico (Cretaceous Symposium, still unpublished). Two papers by Dr. Maync were published during 1957: One on *Coscinophragma cribrosum* (Reuss) (Micropaleontology, vol. 3, no. 2, pp. 183–186), and the other entitled "Aufgaben der Mikropaläontologie in der Erdölindustrie" (Technische Rundschau, Bern, no. 14, pt. 2 (Erdöl), pp. 10–11, 13).

Dr. Maync also had a paper on a new genus of lituolid foraminifera in the January, 1958, issue of the Contributions from the Cushman Foundation (vol. 9, pt. 1, pp. 1–3). Other papers by Dr. Maync are now in press ("Note sur *Pseudocyclammina jaccardi* et sa synonymie," and "*Ammocycloloculina*, n. gen., an unknown foraminiferal genus").

Société de Recherches Pétrolières dans la Région Parisienne
Nanteuil-les-Meaux

The PETROREP stratigraphic laboratory was established in 1956, and began work under the scientific supervision of J. Sigal, of the French Petroleum Institute (I.F.P.). Studies are now continuing under the direction of Miss L. Biot, geologist with PETROREP. After a period of technical instruction of laboratory assistants, operations were directed first toward subsurface stratigraphic determinations and research on markers in the Tertiary and Cretaceous. Research at present is essentially concerned with the Jurassic formations. The organization of a microfacies catalogue, with a classification by series and localities, has been started. About ten volumes are already completed.

Société Esso de Recherches et d'Exploitation Pétrolière
Bègles (Gironde)

In 1957, the technical staff of the Esso R.E.P. laboratory was the same as in 1956 — F. Dalbiez, G. Gaudin and G. Malmoustier. Routine work and correlation of the Cenozoic and Mesozoic sediments were carried on, with both free specimens and thin sections. G. Malmoustier made a special study of the Tertiary microfauna of the Landes region, the results of which will be covered in a report now under preparation. F. Dalbiez has recently published a paper describing a previously unknown *Cuneolina* from the basal Cretaceous sediments of the Aquitaine Basin (Micropaleontology, vol. 4, no. 1, pp. 97–101, January, 1958).

Esso R.E.P. and S.N.P.A. were hosts at a one-week paleontological meeting held in September, 1957, with representatives of ten European countries in attendance. Esso R.E.P.'s contribution to the successful meeting included the organization of a field trip to the type localities of the Santonian, Campanian, and Aquitanian stages. Prior to their departure, some of the participants visited the Esso R.E.P. geological laboratory.

Compagnie Française des Pétroles (Gascogne)
Bordeaux (Gironde)

The laboratory has been continuing stratigraphic work on the sections of the Aquitaine Basin, on the basis of numerous field samples collected on the borders and outside the basin. The principal results are concerned with the following sequences:

Jurassic–Lower Cretaceous: The distinction of two provinces, western and eastern, in the Bajocian–lower

Kimmeridgian interval (including, in part, the *Rasenia cymodoce* zone), is reported, with supporting data, in a paper by J. Cuvillier and P. Dufaure (in press). A rather good interpretation of the Neocomian, which is particularly well developed in the central Pyrenees, was obtained by reference to sections in the region of the "Fosse vocontienne," where the classic stages are dated by ammonite faunas. It is possible to correlate them with the calcareous sections of Provence and western Languedoc (hill of La Clape, near Narbonne). The evolution of the tintinnoids and the distribution of algae and arenaceous foraminifera in each of the environments from the "Tithonian"–Berriasian to the Barremian were also mentioned in passing. From the chronological point of view, it was concluded that the Portlandian (represented in the Purbeckian facies) is equivalent to the "Tithonian"–Berriasian in the south of France. The Neocomian is not present on the northern and eastern borders of Aquitaine. Transgression of the Cenomanian onto the Upper Jurassic is widespread. It overlies the Portlandian at Oleron Island, and the middle Kimmeridgian in the Rochefort bore-hole.

Upper Cretaceous: A detailed study of microfacies and microfaunas has been made in the sections of northeastern and eastern Aquitaine. With the exception of the Campanian, the standard sections of the classic stages do not contain pelagic microfaunas. The Coniacian and Santonian are represented by alternating clastic and coarsely detrital sequences, indicating periods of major movement of the sea-bottom. In the central Pyrenees, it has been shown that strong movement took place in the upper Albian to Cenomanian interval. Rocks with *Prealveolina*, *Orbitolina concava*, *Cuneolina*, *Chrysalidina*, and *Meandropsina* have been found to overlie limestones and dolomites of Dogger age south of Bagnères de Bigorre (Vialette). Eastward, thick sequences of calcareous marl and sandy limestone with *Pithonella* and Globorotaliidae (*Ticinella* and *Thalmanninella*) rest unconformably on beds of Neocomian or Aptian age.

Tertiary: Progress in the census of microfaunas from sections in southern Aquitaine is continuing.

Société Nationale des Pétroles d'Aquitaine Pau (B.-P.) laboratory

A. Debourle, now in charge of the photogeological service, has been replaced by M. Delmas, with Miss Raimbault as assistant. Miss Raimbault has taken Miss Rolland's place. Professor J. Cuvillier is the adviser in laboratory research work. By means of micro-organisms and microfacies, the laboratory staff has studied the stratigraphy of about fifty wells that were started or completed during the year 1957, as well as sections in the front ranges of the northern Pyrenees, in the area between Les Arbailles and Lourdes. Important lateral changes of facies in the Lower Cretaceous have been detected by these studies, and have made it possible to revise the interpretation of the stratigraphy of the Lower Cretaceous in the wells. Some marker horizons with foraminifera, particularly *Epistomina*, were observed.

Numerous foraminifera and Ostracoda have been obtained from the Aptian in wells at Clermont. These are presently being studied, and the results will be published at a later date.

A study of Jurassic rock samples has enabled the laboratory staff to determine very precisely the limits of various microfacies, and to discover some lateral changes, particularly in the Upper and Middle Jurassic. A stratigraphic revision of the Lacq structure, especially concerning the Upper Cretaceous, has also been started. Micropaleontological research (microfaunas) is now under the direction of M. Rey, with Mrs. Aubert as assistant. During 1957, they completed two studies. One was on the Oligo-Miocene of Landes; this work covers the area between Mimizan, Mont-de-Marsan, and Bayonne. The second concerned the Lower Eocene of the Pau area; this study contributed to the evidence of an unconformity between the Ypresian and the Paleocene in the S.N.P.A. wells. On the basis of these new stratigraphic observations, the geological staff, together with the laboratory staff, have been able to construct paleogeographic maps.

Société Nationale des Pétroles d'Aquitaine Montelimar laboratory

This laboratory, established in July, 1957, is directed by J. Faber, assisted by J. Maillard and Miss Leduc. During the first year, activities dealt mainly with the study of microfacies and microfaunas from the Lias to the Upper Cretaceous. Miss Leduc made a stratigraphic study of the Upper Jurassic sequences of the Ardèche district; marker horizons were recognized in the Argovian, Kimmeridgian, and Portlandian. Calpionellids were found to be present from the Portlandian to the Valanginian.

J. Maillard is working on the Upper Cretaceous. In addition to the study of microfacies, he has identified characteristic zones in the Cenomanian and Turonian, on the basis of *Rotalipora* and *Globotruncana* in washed samples. J. Faber is working on the Neocomian; the microfauna is fairly rich. Various species previously identified in North Africa (*Gaudryina chettabaensis*, *Lenticulina ouachensis*, and *Marginulinopsis sigali*) and in Germany (*Lenticulina d'orbignyi schreiteri*, *Frondicularia* cf. *loryi*, *Frondicularia lamellata*, and *Triplasia emslandensis*) have been found in this area.

Société Nationale des Pétroles d'Aquitaine Maxeville (M. et M.) laboratory

During 1957, J. Faber resumed the studies begun by M. Delmas. He was assisted by J. P. Cabrit. In addition to the control of the various wells in this area, the laboratory staff was mainly interested in Lias microfaunas and in the important facies changes of the Dogger in the eastern Paris Basin. Correlations were established in the Dogger between different wells in the eastern Paris Basin.

The Bathonian age of the "*Rhynchonella decorata*" limestones of Neufchâteau (Vosges) and Saint-Blin (Haute-Marne) was confirmed by a study of drill cores. A detailed chart

of the facies variations in the Bathonian was drawn up, showing the presence of the entire Bathonian, together with some new observations (the presence of two sequences of "*Rhynchonella decorata*" limestones near Saint-Blin, and partial dolomitization). Drilling was stopped in October, 1957. The laboratory has been partially transferred to Montelimar.

Société Autonome des Pétroles de Saint-Gaudens

The central laboratory of the S.A.P. has continued its stratigraphic, petrographic, paleontological and micropaleontological work (surface and subsurface) through a large stratigraphic interval, ranging from pre-Cambrian to Tertiary, in the Aquitaine Basin (IIIème Congrès National du Pétrole Français, Pau, May, 1957) and in the Sahara.

Société des Pétroles de Valence (Drôme)

The S.P.V. stratigraphic laboratory has just begun activity. At the end of 1957 it was scarcely organized physically. However, this laboratory so far has been able to handle all the subsurface problems of the Company without outside assistance. No papers have been published to date.

JEAN CUVILLIER
Laboratoire de Micropaléontologie
University of Paris

JAPAN

KIYOSHI ASANO

During 1957, micropaleontological research in Japan progressed remarkably. Major works on fusulinids, small foraminifera, and Ostracoda were published. In addition, biostratigraphic studies, particularly on Cretaceous and Tertiary rocks, were carried on in several parts of Japan. Studies on pollen, diatoms, calcareous algae, and Radiolaria, as well as on fish otoliths, are being continued and are progressing steadily.

Tohoku University

Professor Hanzawa's studies on the microfacies of the foraminiferous rocks of Japan has been completed, and the manuscript has been sent to Dr. Jean Cuvillier in Paris. Publication is expected in the near future.

Professor Asano is continuing his work on the foraminifera dredged by the S.S. *Soyo-maru* from the seas surrounding Japan. He published the fourth paper in the series in the Science Reports of Tohoku University (vol. 29); this paper covers the Buliminidae. A study of Paleogene foraminifera from Kyushu and Hokkaido was also published in the same journal. Asano is now making a biostratigraphic study, using smaller foraminifera, of the Paleogene Poronai formation of the Ishikari coal field and other regions in Hokkaido. From studies of planktonic foraminifera from the Neogene rocks of the Miura and Boso Peninsulas in central Japan, he has determined the stratigraphic sequence and has drawn the boundary between the Pliocene and Pleistocene deposits of those areas, on the basis of evidence furnished by the low-temperature forms and according to the opinion expressed at the International Geological Congress held in London that the first cool-water stage indicates the beginning of the Pleistocene.

Y. Takayanagi's studies on the Cretaceous foraminifera of the Yubari district in Hokkaido are now concerned with the problem of correlation with the ammonite zones hitherto recognized in the Cretaceous formations of Japan. T. Kanaya's research on the Tertiary diatoms of the Hirosaki Basin in Aomori Prefecture is almost completed. H. Fujita has made a biostratigraphic study of the Omi limestone in Niigata Prefecture, where he recognizes several fusulinid zones. The results were published in the Contributions from the Institute of Geology and Paleontology of Tohoku University (no. 48). Professor Hatai is continuing his studies on fish otoliths, but is having difficulty in obtaining Recent specimens for comparison. He has nearly completed his studies on the Pliocene otoliths of the Hamada formation in Aomori Prefecture.

Tokyo University

As a result of studies on Ostracoda made during his visit to the United States, T. Hanai has published two large papers in the Journal of the Faculty of Science of Tokyo University (vol. 10). He has recognized three new subfamilies, the Leptocytherinae, the Pectocytherinae, and the Cytheropterinae. Y. Uchio has returned from his visit to the Scripps Institution of Oceanography. It is expected that his studies on the Recent foraminifera of San Diego will be published as soon as the manuscript is completed.

Tokyo University of Education

H. Igo has published a monographic work on the fusulinids of the little-known Paleozoic of Fukuji District in the southeastern part of the Hida Mountainland, central Japan, in the Science Reports of the Tokyo Kyoiku Daigaku (sec. C, vol. 5). He has also published a paper on some interesting forms of *Triticites* from the same area, in the Japanese Journal of Geology and Geography (vol. 28). In collaboration with Mr. Igo, Professor Fujimoto is now completing a paper on the fusulinid zones of the Japanese Carboniferous. Its publication will contribute greatly to the progress of our knowledge of the fusulinids of the world, as it deals in detail with the many recognizable zones, their distribution, and their faunal characters.

Saitama University

Professor Endo is now President of the University, and official business

is keeping him away from active research, but we must congratulate him on finding time to publish an article on calcareous algae from the Paleozoic rocks of the Hida Mountainland, central Japan. Dr. R. Morikawa is continuing his studies of the fusulinids, using the sump-method, by which he has succeeded in making serial sections with a thickness of 0.05 mm. By means of this method he has been able to study the changes in the characters during the development of the shell. A paper on the subject has been completed and is now awaiting publication.

Hokkaido Gakugei University

Professor Toriyama has just published the paleontological results of his studies of the Akiyoshi limestone, in the Memoirs of the Faculty of Science of Kyushu University (ser. D, vol. 7). This is a very large monographic work on the fusulinids. Assistant Professor Kanmera also published the results of his studies of fusulinids from the Yayamadake limestone of Kyushu in the same publication (ser. D, vol. 6). These two papers are very important contributions to the study of the fusulinids, both of Japan and of the world. K. Takahashi has published several articles on the stratigraphic value of pollen in the Paleogene rocks of Kyushu.

Kanazawa University

Professor Ichikawa has published a paper on Neogene diatoms from Toyama Prefecture. As a result of his continuing work, the diatom floras of the Neogene and younger deposits of Toyama and Kanazawa Prefectures are becoming well known.

Hiroshima University

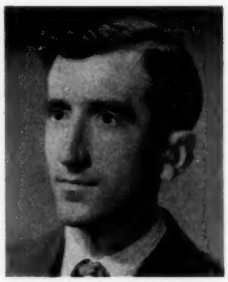
Y. Tai is continuing his studies on the biostratigraphy of the Neogene Tertiary deposits of southwestern Japan, based on the smaller foraminifera.

Other news

Dr. Leo W. Stach has resigned his position with the Chinese Petroleum Corporation of Taiwan and is now a consulting geologist for the Far East Region. Dr. T. Oinomikado, who had also been working in Taiwan with Dr. Stach, is expected to return to Japan shortly.

KIYOSHI ASANO
Institute of Geology and Paleontology
Tohoku University, Sendai

NORTH AFRICA



JEAN MAGNÉ

MOROCCO

Société Chérifienne des Pétroles (S.C.P.)
Laboratoire de Stratigraphie, Petitjean

Several staff changes took place during the course of the year 1957. P. L. Allard, who was in charge of the laboratory, left the S.C.P. in August to work for the Société Française de Recherches et d'Exploitation du Pétrole (S.A.F.R.E.P.) in France. He has been replaced at Petitjean by Miss E. Vincent and Mr. L. Brun. Mrs. J. Aubert also left the laboratory in September, to work in France for the Société des Pétroles d'Aquitaine, at Pau.

During the year the staff studied 4500 thin sections and 2200 washings from the region of Petitjean and Mogador-Agadir. The study of facies and microfaunas of the Cretaceous and Jurassic of southwestern Morocco was continued. Research in the area northeast of Petitjean has revealed a great development of detrital facies in the Dogger, in which micropaleontological study is particularly difficult. It has been found necessary to use granulometric methods.

ALGERIA

University of Algiers

Research work in the two geological laboratories of the University has been carried on under the direction of Professor R. Laffitte and Professor G. Lucas. Miss C. Bernard has continued her work on the Cretaceous Radiolaria (mainly Albian and Cenomanian forms) of Algeria. Miss D. Noël, who specializes in coccolithophorids, has been studying the species of this group in the phosphate-bearing formations of Algeria.

Mrs. G. Glaçon has pursued her research on the Recent foraminifera of the Gulf of Gabès, Tunisia, and on the Eocene foraminifera of the Constantine area, Algeria. J. Emberger has expanded his studies on the fossil algae of Algeria. He has been working especially on the forms of the Visean and Namurian of the western Sahara, with samples furnished by the geological laboratory of S.N.REPAL, and on those of the Permian of southern Tunisia, with samples furnished by the laboratory of S.E.R.E.P.T. He is also pursuing his work on the Mesozoic Chlorophyceae of the Saharan Atlas. P. Muraour has left Algiers to work in Tunis.

Compagnie Française des Pétroles (Algérie) (C.F.P.(A.))

During 1957 the laboratory of the C.F.P.(A.) in Algiers continued to deal with problems of Saharan stratigraphy. V. Sacal has been in charge of the laboratory, under the scientific supervision of Professor J. Cuvillier, of Paris. His coworkers were J. Thouvenin and Miss J. Thibaut, who was transferred to Libya during the course of the year to organize the proposed laboratory of the Company in Tripoli.

A composite stratigraphic report on the Saharan Mesozoic was finished during 1957. The problems in the Paleozoic were of two sorts: 1) The stratigraphy of the Devonian and Carboniferous to the north of the "Tassili-N-Ajjer"; and 2) the sedimentology of the Triassic and Cambrian sandstones that form the Hassi Messaoud reservoir. With the in-

creased drilling activity of the Company, the laboratory has had a great deal of routine work to do during the past year.

Compagnie des Pétroles d'Algérie (C.P.A., Shell)

During 1957 C.P.A.'s paleontological laboratory in Algiers, which is under the direction of M. Millioud, assisted by L. Nijssen, devoted its attention to the study of the Paleozoic and Mesozoic. Quantitative palynology, which has proved very useful in solving problems in the Paleozoic, has also established its value in studies of Mesozoic rocks. It has been found possible to establish good correlations between wells in post-Paleozoic sediments, but the absolute age of the formations remains unknown because of the absence of index fossils. The results of further studies of the Carboniferous has confirmed the belief, mentioned last year, that a part of the strata formerly attributed to the Visean belongs to the Namurian.

Société Nationale de Recherche et d'Exploitation des Pétroles en Algérie (S.N.REPAL)

During 1957, the central geological laboratory of S.N.REPAL in Algiers continued its work on well and surface samples under the direction of Jean Magné. The staff was composed of three laboratory geologists, three assistants, one illustrator, one photographer, two secretaries, and ten laboratory helpers. C. Tempère left Algeria at the beginning of 1957 to work in Paris at the Bureau de Recherches de Petrole (B.R.P.). A. Novikoff replaced him in July, 1957. A total of 3000 washed samples and 5400 thin sections were prepared and studied throughout the year, and a large number of photomicrographs made it possible to complete the card indexes of micro-organisms and microfacies.

Work on microfossils was mainly concerned with small foraminifera, ostracodes, eopteropods, and charophytes. During 1958 the study of conodonts and spores and pollen will be undertaken by the laboratory staff in an attempt to solve problems of microstratigraphy, especially in the Sahara. During 1957 the staff also used microfacies, heavy minerals, and petrographic methods.

As a consequence of political events, the most important work has been carried on in the Sahara. In this broad region the number of drillings was greatly increased, extending the two important oil fields discovered by S.N.REPAL (Hassi Messaoud and Hassi R'mel). Mrs. S. Gassier-Chastanier and A. Novikoff have been studying the Paleozoic and the Triassic. In the Paleozoic, Mrs. Gassier-Chastanier verified the great stratigraphic value of the microfacies identified last year in the Siluro–Devonian. One of the most important results of the year was the discovery of the Middle Carboniferous in marine facies in a well near Bordj Nili, on the northern border of the Sahara. The horizon, attributed to the Moscovian, is characterized by *Fusulina*, *Bradyina* cf. *nautiliformis*, *Globivalvulina*, and other microfossils. These formations were previously known only in southern Tunisia. With the collaboration of Dr. A. Vatan of the Institut Français du Pétrole, Mrs. Gassier-Chastanier also made a detailed study of the thick series of Cambrian sandstones that contain the oil and gas of the Hassi-Messaoud field.

A. Novikoff has been working mainly on Triassic formations, but the Saharan Triassic, which consists of salt, evaporites, colored clays, and sandstones, has not furnished any microfossils. It has been necessary to use heavy minerals and petrographic methods of study.

J. Magné has continued his research on the Mesozoic and Tertiary of the northern Sahara. The microfacies and micro-organisms of the Jurassic have been studied in detail, and the findings will probably be published during 1958. The Malm shows some horizons with *Pseudocyclammina* in the upper part, numerous levels with charophytes, and a reference horizon with mollusks and echinoderms and frequent smooth Ostracoda. The Dogger shows a large quantity of ornate Ostracoda, some arenaceous foraminifera, *Lenticulina*, and rather frequent oolitic facies.

The Lias yields numerous Lagenidae, and contains dolomites with oolites. However, foraminifera are often very rare in these Jurassic sequences. The Cretaceous of the northern Sahara is often unfossiliferous and is usually poor in fossils except for the upper Senonian and Turonian, when they are not invaded by dolomite. The Senonian often shows abundant Dasycladaceae, miliolids, and Rotaliidae. The Turonian principally contains numerous *Fissurina*, *Globigerina*, *Guembelina*, and rudistids.

J. Magné has also continued his detailed studies of the smaller planktonic foraminifera of the Algerian Tertiary, on which he has been working for several years. He has been able to make some interesting comparisons with the Tertiary microfaunas of southern Spain and the Rif (Morocco), on the basis of samples furnished by Professor P. Fallot and M. Durand-Delga. Magné has also been studying the smaller foraminifera of the Cretaceous and Tertiary of the Oued Athmenia region (Constantine area), of the Monts de la Mina (Tell of Oran), and of the Ouarsenis Range (Tellian Atlas). The results have been published in collaboration with the field geologists.

In September, 1957, Magné attended the international colloquium on micropaleontology, which met this year in France, in the western part of the Aquitaine Basin. He visited some famous localities in the region between Biarritz and Les-Sables-d'Olonne under the guidance of Professor Cuvillier and F. Dalbiez. In November Mrs. Gassier-Chastanier attended a colloquium on Paleozoic microfossils of the Sahara, organized by the Institut Français du Pétrole and the Bureau de Recherches de Pétrole in Paris.

Service de l'Hydraulique et Equipement Rural (S.H.E.R.)

The micropaleontological laboratory of the Survey, at Algiers, is now under the direction of Miss Claude Pinard, who has been in charge since November, 1955. The laboratory was established by Miss Ja-

nick Thibaut in December, 1953. The staff consists of seven laboratory workers, including two sample washers, one laboratory assistant to make thin sections, one photographer, two foraminifera pickers, and one typist-secretary.

The total number of samples studied since the beginning now amounts to 5174 washed samples and 4853 thin sections. These samples are systematically photographed, and three prints made of each. These are filed in a photographic card-index, where they are classified analytically (for microfacies and sections of characteristic organisms), stratigraphically, and geographically.

The micropaleontological laboratory specializes in the study of hydrogeologic drillings. The samples studied in the laboratory are collected by the geologists of the Survey, who work in northern Algeria and the Sahara. The activities of the laboratory during 1957 were concerned principally with three subjects. The first was an attempt to correlate, with the aid of microfaunas and microfacies, the great wells drilled in the Saharan Albian in the search for water (Tamerna, Sidi Khaled, Ouargla, Oued Rhir, Mzab, and Souf). In this broad region the Eocene has been dated by means of its excellent fauna of *Nummulites* and *Operculina*, which were studied by Professor J. Flandrin of the University of Lyon. The Senonian is often characterized by a microfacies of glauconitic limestone with bryozoans, *Inoceramus*, and rudistids; the washed samples sometimes yield *Valvulammina parrelloides* Magné and Sigal, *Rotalia algeriana* Magné and Sigal, and several species of *Laffitteina*. The Turonian generally shows bituminous limestones with *Fissurina;* these are known also in the Saharan Atlas. The Albian is characterized by very fine-grained sandstones with heavy minerals and fish teeth.

In collaboration with G. Cornet, a geologist with the Survey, another study was undertaken, concerning the Djelfa area in the Saharan Atlas. Microfaunas with *Dicyclina*, *Cuneolina*, miliolids, Globorotaliidae, *Guembelina*, and *Fissurina* characterize the Upper Cretaceous. A microfacies with *Trocholina*, *Choffatella*, and *Clypeina* distinguishes the Lower Cretaceous (Valanginian-Neocomian).

The third subject of research was a micropaleontological study of drillings for water in the Chott Chergui Basin (Hauts Plateaux of Oran). This study was carried out in detail in order to determine the stratigraphy more precisely. The studies have revealed a facies with algae in the Senonian, and a new genus of foraminifera of the family Meandropsinidae, according to P. Marie of Paris and Professor M. Reichel of Basel, in a horizon heretofore regarded as Bajocian–Bathonian.

TUNISIA

Société de Recherches et d'Exploitation des Pétroles en Tunisie (S.E.R.E.P.T.)

During 1957, the principal efforts of SEREPT's micropaleontological laboratory in Tunis, with C. Glintzboeckel and J. Rabaté in charge, were directed toward a biostratigraphic study of sections encountered during drilling in the south of Tunisia. The Permian in particular has furnished a rich microfauna of fusulinids and smaller foraminifera, the stratigraphic distribution of which has been established. Some of the microfacies have also provided markers, permitting good correlations.

The Carboniferous, which is also very fossiliferous, can also be zoned on the basis of the microfaunas. The Permian and Carboniferous are very rich in algae. Some of these algae were submitted for study to J. Emberger of the Faculté des Sciences of Algiers, who found several new forms. The early Paleozoic has been the object of a special study reaching beyond the scope of micropaleontology. Mr. Bonnefous, recently assigned to the laboratory, has begun a sedimentologic study, especially of the sandstones.

LIBYA

The Compagnie Française des Pétroles recently established a laboratory at Tripoli to study field and well samples from its new areas of petroleum exploration in Libya. Miss Janick Thibaut is in charge of this new stratigraphic and micropaleontological laboratory. Professor J. Cuvillier is the scientific consultant.

JEAN MAGNÉ
Laboratoire de Géologie
S.N. REPAL
Algiers

PERU

EDWIN T. ASHWORTH

The news from Peru during the past year chiefly concerns micropaleontological activities among the various oil companies operating in the northwestern part of the country.

Empresa Petrolera Fiscal

A. Euribe returned to Zorritos after a year on a Point Four scholarship at Stanford University, where he studied under Dr. Hans E. Thalmann. However, he has recently left the Company and is now in Lima. He has been preparing a paper on "The Oligocene fauna from the Heath formation of northwestern Peru." While in the States, he spent some time at the Smithsonian Institution in Washington comparing his faunal material with the collections there.

Federico Seminario is in charge of the laboratory at Zorritos, and is mainly occupied with routine well problems and correlations. Equipment for a small spore and pollen laboratory has been purchased, and preliminary work of this nature is in progress.

International Petroleum Company, Ltd.

At Talara, T. L. Liebetrau recently joined the micropaleontological staff, which consisted of E. T. Ashworth and Fernando Zuñiga. In August, 1957, with the sudden death of Orestes G. Pasapera, the laboratory lost the services of a well-trained self-educated technician, who had consistently performed the duties of a junior micropaleontologist. Paleontological work in the Talara laboratory consists mainly of routine well work and correlation problems. Your reporter is continuing a study of the foraminifera of the Talara formation (Middle to Upper Eocene) of northwestern Peru, the results of which he hopes to publish soon.

In May, 1957, the International Petroleum Company acquired a 50 per cent interest in the concessions of the Compania Petrolera Lobitos, and is now the sole operator of this property located to the north of Talara and adjoining International's present property. A small micropaleontological staff is being maintained at El Alto, the former headquarters of the Compania Petrolera Lobitos, consisting of R. Phillips, of the Lobitos Company, and C. L. Wilmott, a recent International Petroleum employee. They are mainly engaged in well correlation work.

Compania Peruana de Petroleo "El Oriente"

This company is a joint German and Peruvian operation in eastern Peru, in the area of Contamana. Erich Blissenbach is in charge of the micropaleontological work being done in the camp laboratory at Puerto Oriente on the Ucayali River. Studies of Cretaceous and Tertiary rocks are being carried out mainly to establish microfossil zones and for correlating surface and well sections. The microfossils found include ostracodes, charophytes, and sparse foraminifera.

Other news

There is not much news from any of the universities, as only brief introductory courses in micropaleontology are being offered in the geological curricula. Dr. Franz Spillmann, professor of paleontology at the Universidad Nacional Mayor de San Marcos de Lima, was in Talara with twenty-two students for a two-week training visit in January, 1958. Dr. Spillmann is continuing his study of Cretaceous microfossils in Peru, and made several collections of material while in Talara. J. Cruzado, formerly a micropaleontologist with the Empresa Petrolera Fiscal at Zorritos, is now working with the U. S. Geological Survey in Lima.

EDWIN T. ASHWORTH
International Petroleum Company, Ltd.
Talara

PORTUGAL OVERSEAS

ARMÉNIO TAVARES ROCHA

Cape Verde Islands

During 1957, Dr. J. Martins Ferreira published a paper entitled "Sobre os foraminíferos actuais de Cabo Verde." Dr. Herculano Vilela, chief of the "Missão de Biologia Marítima do Ultramar," presented Dr. Ferreira with a series of samples collected during the 1951/52 expedition of the "Missão Hidrográfica de Cabo Verde." Under the auspices of the M.B.U., Dr. Ferreira prepared a report on the Recent foraminifera of the coasts of the Cape Verde Islands, in which he summarized the principal characteristics of the microfauna studied to date. He has identified sixty species of foraminifera from fifty-nine samples, which are distributed as follows: Baía da Palmeira (Sal Island), nine samples; Paúl (northeast of Santo Antão Island), one sample; Ponta do Sol (Santo Antão Island), twenty-nine samples; Portinho Santo (Santo Antão Island), twenty samples. The depths from which these samples were obtained range between 9 and 86 meters, with the majority from between 12 and 40 meters.

The most frequent species are *Amphistegina lessonii* d'Orbigny, *Elphidium crispum* (Linné), *Globorotalia menardii* (d'Orbigny), and *Globigerinoides ruber* (d'Orbigny). The first is the most widely distributed, followed by *Elphidium crispum*. A long list of the benthonic and planktonic forms identified is included in the paper.

Ferreira compares the Cape Verde fauna that he studied with the fauna described by Dr. J. Santos Pinto in his paper entitled "Sedimentos marinhos da Guiné Portuguesa." As a result of this comparison, Ferreira notes certain differences. He reports that the two faunas are similar only with regard to the abundant representation of the family Miliolidae, and he concludes that the two faunal provinces (Cape Verde and Guinea) are characterized by different associations.

This interesting study not only makes available a knowledge of the microfauna present on the coasts of the Cape Verde Islands, but also has aided in the establishment of a National Collection from the Archipelago, which may be useful in future comparative studies. The author has attempted to call the attention of Portuguese students to this field, which is highly important both from a scientific point of view and from a practical one.

São Tomé and Principe Islands

Professor L. Berthois recently published a paper entitled "Contribution à l'étude lithologique des roches sedimentaires des îles de São Tomé et Principe" (Lisbon, Univ., Fac. Ciên., Mus. e Lab. Min. Geol., Bol., ser. 7, no. 23, pp. 45–69, 1955). He presents a petrographic and granulometric study of radiolarian-bearing coarse sandstones, fine sandstones without microfauna, and phosphatic rocks with Radiolaria and foraminifera, from São Tomé Island. He reports the radiolarian genus *Nasse-*

laria, and foraminifera of the families Rotaliidae and Globigerinidae. Some of the samples were obtained during the course of exploration for petroleum, and form part of a collection made by A. C. Mendelson in 1941. The author concludes this portion of the paper with a comparative study of the sandstones of São Tomé Island and those of Gabon and the Ivory Coast, indicating that the microfossils do not furnish any indications as to the age of the São Tomé sandstone.

Berthois also discusses petrographic and chemical studies of the limestones of Principe Island. An abundant fauna (both macro- and microfauna) of Miocene age is present. Among the most numerous fossils are foraminifera of the families Miliolidae (genera *Triloculina* and *Quinqueloculina*), Globigerinidae, Peneroplidae, Textulariidae, and Nummulitidae; Bryozoa; Coelenterata; calcareous algae (*Lithothamnium*); spicules of Alcyonaria; and ostracode valves.

Angola (Portuguese West Africa)

A. Tavares Rocha and J. Martins Ferreira have published a paper entitled "Contribuição para o estudo dos foraminíferos do Terciário de Luanda" (Revista "Garcia de Orta," vol. 5, no. 2, pp. 297–310, Lisbon, 1957). The authors present the results of their micropaleontological studies of samples from S. Pedro da Barra (Luanda). They have identified a number of benthonic and planktonic forms, among which the predominance of *Uvigerina* is noteworthy. The most abundant species of the genus is *Uvigerina barbatula* Macfadyen. They conclude their report with the following ecologic and stratigraphic observations: 1) The fauna studied suggests deposition in waters of low and medium temperature and medium depth; 2) as for the stratigraphic position, the frequency of certain forms, such as *Orbulina universa*, *Orbulina suturalis*, and *Biorbulina bilobata*, that are known only from the Oligocene and younger rocks, associated with the characteristic Oligo-Miocene form *Globigerinoides bispherica*, places these deposits in the Miocene.

Ferreira and Rocha have also published another paper, "Foraminíferos do Senoniano de Catumbela" (Revista "Garcia de Orta," vol. 5, no. 3, pp. 517–545, Lisbon, 1957). In this paper they report the results of a study of small foraminifera in a sample from Catumbela, Angola. The authors have identified fifty-six species not previously reported from Angola. The wealth of pelagic forms and the ecology of the genera permit the assumption that this fauna inhabited waters of medium to great depth and low temperature. From the stratigraphic point of view, the presence of the genera *Ventilabrella*, *Planoglobulina*, *Schackoina*, and *Globotruncana* makes it possible to assign a Senonian age to these deposits. In addition, the abundance of *Globotruncana arca* appears to restrict the stratigraphic position of these deposits to the Campanian or Maestrichtian stage.

ARMÉNIO TAVARES ROCHA
Lisbon

UNITED STATES – ROCKY MOUNTAIN REGION

DANIEL J. JONES

The pace of micropaleontological activity in the Rocky Mountain region has accelerated considerably during the past year, both in the colleges and universities and in oil company work. Most of the research activity seems to center around (1) the palynology of the Cretaceous and Tertiary formations; (2) the foraminifera of the Cretaceous; and (3) the use of endothyroid and fusulinid foraminifera in the correlation of Carboniferous and Permian strata. Other work ranges from studies of nonmarine ostracodes to Mesozoic coccoliths.

Noteworthy among published micropaleontological papers on this area is Herbert Skolnik's paper "Lower Cretaceous foraminifera from the Black Hills area" (Jour. Pal., vol. 32, no. 2, pp. 275–287, 1958), in which he describes an all-arenaceous lagoonal assemblage of foraminifera from the Skull Creek shale and the Newcastle sandstone. A Lower Cretaceous (Fredericksburg to Washita) age is assigned to the fauna. M. L. Thompson, H. W. Dodge, and Walter Youngquist are continuing their fusulinid studies in the Rocky Mountains with a paper entitled "Fusulinids from the Sublett Range, Idaho" (Jour. Pal., vol. 32, no. 1, pp. 113–125, 1958). The fauna is Upper Pennsylvanian to Wolfcampian in age, characterized by *Oketaella*, *Schubertella*, *Dunbarinella*, *Triticites*, *Pseudofusulina*, and *Schwagerina*. Several new species were noted. Endothyroid foraminifera from the Mississippian of Utah and Arizona have been described by Edward J. Zeller (Jour. Pal., vol. 31, no. 4, pp. 679–704, 1957).

Additional papers of micropaleontological significance include one by J. W. Verville, on "Wolfcampian fusulinids from the Tensleep sandstone in the Big Horn Mountains, Wyoming" (Jour. Pal., vol. 31, no. 3, 1957), and a discussion of the zonation of two sections of the Mancos shale in the Book Cliffs of east-central Utah, on the basis of spores, pollen, hystrichospherids, and microforaminifera. The latter paper, by Roberto Sarmiento, appeared in the Journal of Paleontology (vol. 31, no. 8, 1957).

University of Arizona, Tucson

Dr. Halsey Miller reports that he has one student, Lynn Mackinson, studying Pennsylvanian fusulinids from Arizona. Dr. Miller is continuing to accumulate fusulinid-bearing samples from Pennsylvanian and Permian sections for future study.

The new geology building nearing completion on the campus at Tucson will house a micropaleontology laboratory with several new microscopes for student use, and adequate collection and storage space.

University of Colorado, Boulder

John Chronic and his wife, Halka, are at the University of Edinburgh for the current academic year. Dr. Chronic is teaching paleontology there on an exchange lectureship. Dr. Gordon Craig, lecturer in paleontology at Edinburgh, will fill his post at Boulder.

Dr. Donald Eicher has joined the staff of the Department of Geology this year, with the rank of Assistant Professor. He received his Ph.D. from Yale University, writing a dissertation on Cretaceous foraminifera from Wyoming. Dr. Eicher will teach a course in micropaleontology. John D. Hill, who has been teaching micropaleontology on an interim basis, spent the summer in the Cherry Canyon Mountains of Nevada, completing the field work for his doctoral dissertation.

Dr. Chronic reports that Howard Ellis and Calvin Stevens completed their theses for the master's degree during the spring of 1958. Ellis' work on a limestone facies of the Fountain formation near Denver was reported at the Rocky Mountain Sectional Meeting of the Geological Society of America in Golden, Colorado, also in the spring of 1958. Microfossils recovered from the limestone include fusulinids and problematical fossil fragments which may be barnacle plates.

Other graduate work in micropaleontology now in progress at the University of Colorado includes that of Harry Kent, instructor in geology at Colorado College, who has begun research on the foraminifera of the Mancos shale of northwestern Colorado for his doctoral dissertation. James Puffin is studying the stratigraphy and paleontology of the Pennsylvanian in the Molas Lake region of the San Juan Mountains for his M.S. degree, and James Gigone and Victor Mayer are engaged in studies of the Mississippian and Pennsylvanian of the eastern end of the Uinta Mountains for their theses.

Colorado School of Mines, Golden

J. Harlan Johnson, Professor Emeritus, is now devoting his entire time to his algal studies. He is continuing his work on the modern and fossil lime-secreting algae of the Pacific Islands. His work on the algae of Saipan and Guam will appear shortly as Professional Papers of the U. S. Geological Survey.

L. W. LeRoy is completing his studies of the foraminiferal faunas of the Okinawa region, under the joint sponsorship of the U. S. Navy and the U. S. Geological Survey. Professor W. F. Matier is studying the foraminifera from cores taken in the Arctic Ocean about 200 miles from the North Pole. The cores were obtained by the U. S. Navy from Air Force Island AT-3. He is also completing an ecological study of the foraminifera and sediments of the Arctic in the vicinity of Point Barrow.

Colorado Western College, Gunnison

John Welch, who has been teaching here during the past year, returned to the University of Utah in the fall of 1957 to continue his work toward the Ph.D. degree. He has just completed a paper on the index fusulinids of the Hermosa formation for the guidebook of the 1958 Field Conference of the Intermountain Association of Petroleum Geologists. His present research also includes a restudy of the fusulinid faunas of the Pennsylvanian Oquirrh formation of Utah.

U. S. Geological Survey, Denver

Miss Estella Leopold is continuing her research on the Tertiary pollen of the Western Interior. Richard Rezak, algal specialist, left the U. S. Geological Survey in August, 1957, and joined the staff of the Division of Exploration and Production Research, Shell Development Company, in Houston, Texas. Dr. Rezak presented a paper before the Geological Society of America at Golden, Colorado, in the spring of 1958, on the Cretaceous coccoliths of the Rocky Mountain region. He reported that in chalky facies of the Niobrara, coccoliths make up as much as 85 per cent of the total lithology.

Richard Scott has completed the manuscript of a report on the Triassic and Jurassic fossil woods of the United States, and is now working with Miss Leopold on the Tertiary pollen of the Front Range of Colorado and of the Bridger Basin in Wyoming. They are also studying the pollen floras of peat beds in the State of Washington.

Montana State University, Missoula

Robert Fields reports that he is stimulating some interest in research on spores and pollen among graduate students. Under his direction, Charles Achauer completed a master's thesis on the stratigraphy and paleontology of the Sappington formation of southwestern Montana. On the basis of the conodonts and spores found in shale members of the Sappington, Achauer concluded that the formation is Mississippian, and is correlative with the Lodgepole formation of central Montana. Dr. Fields hopes that their department can soon add a micropaleontologist with a background in palynology to the staff.

University of Nevada, Reno

Professor Joseph Lintz, Jr., writes that his own research on the Pennsylvanian system in Nevada is continuing, and that he is sectioning fusulinid foraminifera for study in the near future. In addition, several oil companies working on the late Paleozoic section in various parts of Nevada continue to employ fusulinid studies as important components of their stratigraphic work.

New Mexico Bureau of Mines and Mineral Resources, Socorro

Dr. Christina Lochman-Balk reports that Gus Armstrong, a Ph.D. student at the University of Cincinnati, has two papers on the micropaleontology of New Mexico

in press: (1) "The Mississippian of west-central New Mexico," to be released shortly as Memoir no. 5 of the New Mexico Bureau of Mines and Mineral Resources; and (2) "Mississippian endothyroid faunas from northern and central New Mexico," to appear in the Journal of Paleontology.

Dr. Lochman-Balk also tells us that there is now a micropaleontologist, W. E. King, at Eastern New Mexico University. King presented a paper entitled "A Dimple limestone microfauna from the Marathon Basin of Texas" at the Permian Basin Sectional Meeting of the Society of Economic Paleontologists at Midland, Texas, in March, 1958. According to Dr. Lochman-Balk, King has several students engaged in similar micropaleontological projects.

University of New Mexico, Albuquerque

Roger Y. Anderson, who teaches micropaleontology at the University, completed his doctorate at Stanford University in the spring of 1958, under the direction of Hans Thalmann. The subject of his dissertation was the pollen of the Upper Cretaceous section in the eastern portion of the San Juan Basin, New Mexico. Dr. Anderson is the author of a recent paper in "Micropaleontology" describing a micromanipulator which he developed in the course of his palynological research. He hopes to initiate further research studies in palynology at the University of New Mexico in the future.

Dr. Anderson is also engaged in ecological studies of the ostracodes of Lake Estancia, New Mexico, and has initiated a series of ethnopalynological studies of archaeological sites in various parts of New Mexico. Under Dr. Anderson's direction, the following M.S. thesis projects are now under way, all concerning the extremely fossiliferous Pennsylvanian section near Jemez Springs: Peggy Lou Carter is completing a study of the bryozoans, Thomas L. Carten is working on the spores, and W. L. Werrell is describing and illustrating the ostracodes.

Brigham Young University, Provo

Dr. Keith Rigby reports that he and several students are continuing their micropaleontological investigations of endothyroid foraminifera from the Mississippian of central Utah. Some work is also in progress on fusulinid foraminifera from the Pennsylvanian and Permian.

University of Utah, Salt Lake City

Daniel J. Jones, who was promoted to full professor of geology on July 1, 1958, is offering a new course, "Stratigraphic Micropaleontology," during the fall quarter. Lectures will deal with the principles of faunal analysis, paleoecology, and displacement of microfossils, and laboratory work will consist of detailed identification of selected microfaunas from the Paleozoic, Mesozoic, and Cenozoic sections in various geological provinces of North America.

In his own research, Dr. Jones has completed a paper entitled "Displacement of microfossils," which will appear in the fall of 1958 in the Journal of Sedimentary Petrology. His studies of the nonmarine ostracode horizons in the Lower Tertiary of the Uinta and Bridger Basins are nearing completion, under a grant from the Penrose Fund of the Geological Society of America. The ostracode horizons are correlated stratigraphically with the principal vertebrate horizons of the Paleocene and Eocene of these basins. Other research work includes "Ostracode biofacies around Santa Catalina Island, California," the manuscript of which is being edited for publication, and "Ostracode biofacies of a portion of the Arctic Ocean north of Ellesmere Island," which Jones completed while at the Hancock Foundation for Marine Research of the University of Southern California during the summer of 1958. His long-term study of the nonmarine Ostracoda of Pleistocene Lake Bonneville is nearing completion with the investigation of the ostracodes recovered from a deep core near Great Salt Lake, penetrating over 1000 feet of Lake Bonneville offshore sediments. The cores were taken under the direction of Dr. A. J. Eardley, under the auspices of the Penrose Fund of the Geological Society of America.

Miss Mona Wheelwright completed her M.S. thesis in the spring of 1958, under the direction of Dr. Jones, and is presently employed by the Humble Oil & Refining Company at Houston, Texas. Her thesis, "Palynology of some typical Utah coals," embraces the pollen and spores of several Upper Cretaceous and Eocene horizons in Utah and southwestern Wyoming.

Several students are at present engaged in various micropaleontological research projects as the subjects of master's theses. Peter Fischer is working on the microfaunas of the Tropic formation in southern Utah; John A. Beard is investigating the Upper Cretaceous section and its microfossils in the Price River Canyon area; Carl Glissmyer and Paul Green are working on stratigraphically adjacent Upper Cretaceous faunas at the eastern edge of the Wasatch Plateau; Carol D. Cohen is studying the possible occurrence of coccoliths in the marine Jurassic of northeastern Utah; and Duane G. Stone is studying the conodont faunas of the Paradox formation in the Paradox Basin of the Four Corners area.

University of Wyoming, Laramie

Dr. Donald Boyd, who teaches micropaleontology, maintains his active research on lime-secreting algae. At present he is studying the algae of the pre-Cambrian and of the Tertiary Green River formation in Wyoming.

Oil company activity in the Rocky Mountains

George Lutz, Divisional Paleontologist of the Shell Oil Company in Salt Lake City, reports the following activities of his company: In the Salt Lake City Division Office are George Lutz, Divisional Paleontologist, Peter Fischer, who works with smaller foraminifera, and Roy Waite, who, with the help of two technicians, handles the fusulinids and megafossils. Blair Maxfield and

his assistant, Bob Logan, are also attached to the Salt Lake District. In the Grand Junction, Colorado, District are Fred Griesbach, Bert Woodland, and Mike Trapesonian. Lee Holcomb, paleontologist in the Four Corners Division, is preparing for the construction of a sample-washing laboratory to be installed in Shell's new building at Farmington, New Mexico. With him in the Farmington District are Jack Hammond, Gene Gregory, Bill Roberts, and assistant Ted Cannon. Work on small foraminifera by Shell has been primarily in the Upper Cretaceous, where they are of great value both for correlation purposes and for the interpretation of paleoecology.

The exploration research laboratory of the El Paso Natural Gas Company in Salt Lake City is undergoing some expansion. James Osborne, micropaleontologist in charge, reports that in the future his activities will be company-wide. At present, his staff consists of four micropaleontologists in full-time work, three in part-time work, and one full-time technician in charge of sample preparation and the filing of samples and slides.

J. F. Clements, micropaleontologist and stratigrapher with the Carter Oil Company in Denver, reports that he has been working on the Upper Cretaceous foraminifera of the Rocky Mountains as part of his stratigraphic investigations. Jay Marks has joined Carter's stratigraphic group in Denver, after twelve years of micropaleontological work in South America. His facies studies on various Paleozoic units include a considerable amount of micropaleontological study.

From Casper, Wyoming, R. L. Heacock reports that the Shell Oil Company is continuing work on the Mesozoic microfossils of the eastern Rocky Mountains and western Great Plains. Heacock is assisted by P. J. O'Donnell and B. W. Gregory.

DANIEL J. JONES
University of Utah
Salt Lake City

UNITED STATES – WEST COAST

HANS E. THALMANN

More than two years have passed since the writer submitted his last report on the activities in micropaleontology on the West Coast. This delay was mainly due to the fact that during 1956 the organization of the meetings and proofreading of the publications of the Twentieth International Geological Congress in Mexico City consumed a tremendous amount of time, and that during 1957 your correspondent was away from Stanford for seven months, traveling and collecting micropaleontological samples in Mexico and Europe. There is no need to offer here a report on what has happened and who presented a paper or took part in the discussions during the Congress in Mexico. It should, however, be pointed out that, for the first time in the history of the International Geological Congress, a separate section (Section X: Micropaleontology), under the chairmanship of your correspondent, brought the micropaleontologists of all countries together. More than fifty papers on all phases of micropaleontology were announced in the program of Section X, but when the meetings were under way, many of the authors were not present, and their papers had to be presented by title only. This resulted in some disturbance of the time schedule, but the ex-tempore meeting at which the Danian problem was discussed, with H. B. Stenzel as chairman and H. G. Kugler and E. H. Rainwater as secretaries, was a great success. It will undoubtedly be remembered by all who attended it as one of the highlights of the micropaleontological sessions during the Congress. It was decided to hold similar informal discussion meetings on the Danian and Maestrichtian, and possibly also on the Aquitanian, during the Congress to be held in Denmark in 1960. A severe hurricane, making roads and rivers impassable, did not permit the planned excursion to the famous type localities of the Tertiary sequence along the East Coast of Mexico, but in view of such a possibility, arrangements had been made beforehand with the Paleontological Laboratory of Petroleos Mexicanos to provide sample type material to all who were interested.

Your correspondent attended the annual meeting of the Society of Economic Paleontologists and Mineralogists, which was held in Los Angeles from March 10 to 13, 1958. At a joint session with the American Association of Petroleum Geologists, Marcus A. Hanna, Charles E. Decker, and Hans E. Thalmann were elected Honorary Members of the S.E.P.M. During the four-day program, the following papers were among those presented: O. L. Bandy and R. E. Arnal, "Concepts of foraminiferal paleoecology"; A. W. Marianos and R. P. Zingula, "Cretaceous foraminifera from Dry Creek, Tehama County, California" (the first well-studied foraminiferal fauna from Lower and Upper Cretaceous beds in northern California); W. E. Hendrix, "Foraminiferal shell form, a key to sedimentary environment" and "A new method of foraminiferal correlation"; C. E. Decker, "What higher magnification is doing for the study of graptolites"; W. R. Riedel, "Siliceous organic remains in pelagic sediments"; P. D. Blackmon and Ruth Todd, "Mineralogy of foraminifera as related to their classification and their ecology"; R. R. Lankford, "The distribution and ecology of Recent foraminiferal assemblages from the eastern margin of the Mississippi delta"; D. J. Jones, "Ostracode biofacies around Santa Catalina Island, California"; and Paul Tasch, "Conodont control of pellet formation in the basal Maquo-

keta of Iowa." W. T. Rothwell and E. L. Winterer conducted field trips for collecting microfossil samples in the Los Angeles and Ventura Basins.

M. L. Thompson, editor of the Journal of Paleontology, has informed the writer that the genera and species index to the first twenty-five volumes of the Journal of Paleontology is now going to press and will be published during 1958. This index has been compiled by H. E. Thalmann and W. Maync, with the collaboration of R. L. Langenheim, Louise Jordan, Augusta H. Kemp, Myra A. Keen, I. B. Gold, J. J. Graham, C. C. Church, Mrs. D. L. Bryant, M. A. Furrer, and Marianne U. Thalmann.

Thalmann's index to the genera and species of foraminifera published from 1890 to 1950, a continuation of Sherborn's famous "Index," which was recently reprinted by the Smithsonian Institution of Washington, D. C., is now in the hands of the George Vanderbilt Foundation, Museum of Natural History, Stanford University, Stanford, California, and is at last scheduled to be printed during the summer of 1958. The manuscript has been ready for the printer since the fall of 1954.

News of micropaleontological activities on the West Coast has been received from the following institutions:

San Diego State College
San Diego, California

E. Dean Milow is finishing his Stanford University Ph.D. thesis, which is on the taxonomy and paleoecology of Eocene foraminifera in the San Diego area.

Scripps Institution of Oceanography
La Jolla, California

Jean Peirson Hosmer has sent in the following report of activities in the Marine Foraminifera Laboratory during the past year:

During 1957, three papers were published by members of the laboratory staff. Fred B Phleger and Robert R. Lankford had a paper entitled "Seasonal occurrences of living benthonic foraminifera in some Texas bays" in the Contributions from the Cushman Foundation (vol. 8, pt. 3, pp. 93–105); Robert R. Lankford and Joseph R. Curray reported on a "Mid-Tertiary rock outcrop on continental shelf, northwest Gulf of Mexico" (Bull. Amer. Assoc. Petr. Geol., vol. 41, no. 9, pp. 2113–2117); and John S. Bradshaw wrote on "Laboratory studies on the rate of growth of the foraminifer '*Streblus*' *beccarii* (Linné) var. *tepida* (Cushman)" (Jour. Pal., vol. 31, no. 6, pp. 1138–1147). Fred B Phleger has a paper entitled "Rates of deposition in the northern Gulf of Mexico based on foraminifera" in press, to be published as part of the reports of the International Geological Congress. He is at present working on foraminiferal populations in lagoons in northern Mexico. This work forms part of a larger project concerning the processes of formation, sedimentation, and history of development of various types of coastal lagoons. Jean Peirson Hosmer and Robert R. Lankford are assisting in this work.

Frances L. Parker has a paper in press (Swedish Deep-Sea Expedition Reports) on foraminifera in surface sediments and cores from the eastern Mediterranean. She is presently working on seasonal studies of living foraminifera in the Poponesset Bay area of Cape Cod, and on planktonic foraminifera in surface sediments of the Pacific.

Takayasu Uchio received his doctoral degree in September, 1957, and has returned to Japan, where he is affiliated with the Department of Mining at the University of Tokyo. The title of his thesis, which is now being prepared for publication, is "Ecology of living benthonic foraminifera from the San Diego, California, area."

John S. Bradshaw received his doctoral degree in December, 1957, and is at present continuing his work on foraminiferal cultures at the Marine Biological Laboratory, Plymouth, England. The title of his thesis is "Ecology of living planktonic foraminifera in the North and Equatorial Pacific Ocean."

Robert R. Lankford is studying the ecology of foraminifera of the nearshore turbulent zone, and has completed a paper entitled "The distribution and ecology of Recent foraminiferal assemblages from the eastern margin of the Mississippi Delta."

Frank Sullivan, a student in the Department of Paleontology at the University of California at Berkeley, has joined M. N. Bramlette in work on coccolithophorids. Part of this work involves a detailed study of the sequence in Lodo Canyon and a comparison with the Middle and Lower Eocene of France and of the Gulf of Mexico coastal region.

William R. Riedel's investigations on Radiolaria in Pacific sediments are currently directed toward the determination of forms which may prove useful in the paleoceanographic interpretation of deep-sea sediment cores; the distributions of some species have been found to correlate with surface-water temperatures. A study of Radiolaria in Antarctic sediments collected by the B.A.N.Z.A.R. Expedition was completed in 1957.

University of Southern California
Los Angeles, California

Orville L. Bandy has sent in the following report of activities:

Johanna Resig, research assistant at the Allan Hancock Foundation, is making an extensive survey of the plankton and foraminifera of the continental shelf between Point Conception and the Mexican border. She has already finished one or two preliminary reports. Recent reports published by some of the graduate students include those of R. L. Knight, of the Shell Oil Company, on fusulinids of Nevada; W. R. White, of The Texas Company, on the foraminifera of the Capistrano formation; R. L. Pierce, of the Richfield Oil Company, on Miocene foraminifera and fish scales from the Santa Monica Mountains; and R. E. Arnal, of the Western Gulf Oil Company, on abnormal foraminifera.

Other studies in press include those of E. Zalesny on the foraminifera of Santa Monica Bay; Johanna Resig on the foraminifera of the Santa Cruz Basin; and R. McGlasson on foraminiferal biofacies around Santa Catalina Island. Daniel Jones, of the University of Utah, taught two classes at the University of Southern California during the summer of 1957, and worked during that time in the micropaleontology laboratory on the Recent ostracodes of the Santa Catalina samples. He plans to finish this report at an early date. Other papers now being prepared for publication include one by M. Reiter on intertidal foraminifera, and another by K. Green on Arctic foraminifera.

Some of Bandy's research includes a recently published study of foraminiferal ecology in the northeastern Gulf of Mexico (U. S. Geol. Survey, Prof. Paper no. 274–G, 1956); a study, in collaboration with R. E. Arnal, of the distribution of foraminifera off the west coast of Central America; and another report with R. E. Arnal on some new species from the Tertiary of California. A report on the paleoecology of Tertiary foraminifera was made at the March, 1958, meeting of the American Association of Petroleum Geologists and the Society of Economic Paleontologists and Mineralogists, at Los Angeles.

Recent visitors to the Southern Californian micropaleontology laboratory were E. Boltovskoy, of Argentina, and Gilbert Nouet and Madelaine Neumann, both from France.

California Research Corporation
La Habra, California

Since the summer of 1957, Alfred R. Loeblich, Jr., has been employed as Senior Research Paleontologist. He writes that he is "doing the usual things with forams that most oil companies do. Not much that the news report would find exciting." We all hope that he will be permitted to continue publishing his findings from time to time, and in a manner similar to that of the beautifully executed "Studies in foraminifera" by A. R. Loeblich and others, recently issued by the U. S. National Museum (Bull. 215, 323 pp., 74 pls., 1957).

Stanford University
Stanford, California

Joseph J. Graham, in collaboration with Priscilla Militante, is finishing a monograph on Recent foraminifera around the Philippine Islands. The material used in this study was collected during his two-year stay, during 1955 and 1956, at the University of the Philippines in Quezon City. Graham is also working with Clifford C. Church on an interesting Cretaceous foraminiferal fauna from outcrops on the Stanford campus, and is directing the "Stanford Cretaceous Micropaleontological Project." The latter is a long-term study for the purpose of investigating, as completely as possible, the micropaleontological content of California Cretaceous sediments and the value of diverse microfossils in their zonal classification. In order to achieve this goal, an advisory council (C. C. Church, L. G. Hertlein, O. P. Jenkins, D. L. Jones, R. M. Kleinpell, J. H. McMasters, and W. C. Putnam) and a board of consultants (J. W. Durham, G. D. Hanna, G. L. Harrington, M. A. Keen, S. W. Muller, G. B. Oakeshott, E. L. Packard, M. B. Payne, W. P. Popenoe, H. G. Schenck, W. C. Smith, P. D. Snavely, and H. E. Thalmann) have been organized. The project is now well under way, with the participation of several graduate students at Stanford University. The writer hopes to have more news about this Project and some of its results in his next news report.

Agostin Ayala, a graduate student from Mexico, is finishing a paper on foraminifera (mostly in thin sections) from Cretaceous limestones of Haiti. He is also studying some excellently preserved specimens of Cretaceous *Orbitolina* from Chiapas, Mexico. Ruben Martinez Pardo, a graduate student from Chile, is working on the taxonomy of the genera *Textularia*, *Spiroplectammina* and *Bolivinopsis*. Lewis Martin is finishing his thesis on the foraminiferal content and stratigraphy of Upper Cretaceous sediments in the Panoche area of California. Raymond Charles Douglas presented a monograph on "The foraminiferal genus *Orbitolina* in North America" as a Ph.D. thesis in March, 1957. In March, 1958, York T. Mandra passed his Ph.D. examination with a monograph on "California fossil Silicoflagellata." William W. Hay, a graduate student, has undertaken the task of describing the foraminifera and biostratigraphy of the Paleocene Velasco formation of eastern Mexico, as a future Ph.D. thesis.

Hans E. Thalmann is busy compiling the data for his annual bibliography and index to foraminifera for the years 1955, 1956, and 1957. He is also working on a collection of more than 200 thin sections of Cretaceous limestones from the Sierra Guzmantla, Veracruz, Mexico, and is doing some research on the micropaleontology of the Cretaceous limestone of the Permanente Quarry near San Jose, California.

United States Geological Survey
Menlo Park, California

Merle C. Israelsky is so busy with special problems assigned to him that he has not found the time necessary to continue publishing the remainder of his "Foraminifera of the Lodo formation of central California." Only two parts of this monograph have been issued to date (U. S. Geol. Survey, Prof. Paper no. 240–B). Weldon W. Rau is devoting his attention to the foraminifera of the Tertiary sediments of Oregon and Washington. Some of his results were recently published in the Contributions from the Cushman Foundation.

University of California
Berkeley, California

Zach M. Arnold has submitted the following report:

All of the student research mentioned in MICROPALEONTOLOGY (vol. 2, no. 2, p. 200, April, 1956) has resulted either in publication or in the presentation of a graduate thesis.

Robert M. Kleinpell's students are currently engaged in research on the foraminifera of the Lower Tertiary of California, in the following areas: 1) Mary McCall, a well near Stockton; 2) Robert Kaar, surface outcrops in San Benito County; 3) Edward Woodside, outcrop samples also from San Benito County; 4) Tom Ross, a well in Ventura County; and 5) Roberta Christensen, surface outcrops in the Santa Cruz Mountains.

The Museum of Paleontology of the University of California has undertaken, as a major research and publication effort, the detailed description and biostratigraphic evaluation of the Lower Tertiary foraminifera of California. Under the direction of Robert M. Kleinpell, approximately two dozen graduate students have completed Ph.D. or M.A. theses within this general field of investigation and have deposited almost 6000 primary and secondary types of foraminifera in the Museum's collections during the past ten years. Substantial progress has already been made in illustrating these foraminiferal faunas, as a result of financial assistance provided by the Museum of Paleontology, the National Science Foundation, and the Shell Oil Company. The following artists are or have been associated with this program: Mrs. G. D. Hanna, Mrs. Emily Reid, Miss Joan Sischo, Miss Mary Taylor, Walter Schwarz and Gene Christman.

V. Standish Mallory, of the University of Washington, has submitted a manuscript to the American Association of Petroleum Geologists, in which he has summarized his extensive studies of the distribution of fossil foraminifera in the Lower Tertiary of the United States West Coast. On the basis of these studies, he has established a stratigraphic classification for this area. Mallory's types of foraminifera, deposited as a result of this graduate research work at the University of California, are an important part of the Museum's micropaleontological type collection.

R. L. Langenheim's routine examination of insoluble residues of western Paleozoic limestones, as a part of his stratigraphic studies, continues to yield interesting microfaunas, which are being added to the Museum's collections. Robert M. Kleinpell is on sabbatical leave during the academic year 1957–58. Zach M. Arnold is still working on the problem of variation in miliolid culture populations, between lectures and the performance of administrative duties as Acting Director of the Museum of Paleontology. Arnold will be on sabbatical leave during the academic year 1958–59, which he expects to spend in Europe. Hans Thalmann, of Stanford University, will take over Arnold's lectures, seminar, and laboratory work during the fall semester of 1958–59, in addition to teaching his courses at Stanford University.

University of Washington
Seattle, Washington

On behalf of V. Standish Mallory, Robert D. Mears, Curator of the Museum of Paleontology, reports as follows:

V. Standish Mallory has a paper now in press dealing with the biostratigraphy of the Lower Tertiary of the West Coast Ranges, which will prove to be a very interesting and important contribution to micropaleontology. Betty J. Enbysk, of the Geology–Oceanography Department, is working at present on two projects. One will be published shortly, and deals with the microfauna of Cobb's seamount. The other will be published later in 1958, and is concerned with a study of the ecology of Recent benthonic foraminifera in the area stretching from the Gulf of Alaska to Cape Blanco in Oregon. Warren S. Drugg, of the Geology Department, is completing his Master's thesis on the microfauna and stratigraphy of the Hoko River area in the Olympic Peninsula of Washington, which is to be published. Gene Bagley, also of the Geology Department, is working on a Master's thesis on the microfauna and stratigraphy of the Seiku River area in the Olympic Peninsula. This paper will also be published. James Bush has recently finished his Master's thesis, on the Recent foraminifera of Biscayne Bay in Florida. It is not yet certain whether or not this study will be published.

HANS E. THALMANN
Stanford University
California

index to volume 4

Author index

Subject index

NOTE: *New terms and names of new taxa are set in* ***bold-face*** *type. Numbers in parentheses refer to papers listed in the author index.*


M. Leidel